Copper industry's response to the criteria for qualitative assessment of eligibility of sectors for indirect cost compensation: Executive summary

Strategic commodity: Copper is a key material for the energy transition facilitating GHG emission reductions in numerous other sectors, from renewable energy generation, through energy efficient end-use appliances to electrified transport, heating and cooling systems. It is also a key material in battery production. Copper contributes to resource efficiency as important carrier metal enabling the recovery of many valuable metals needed for today's energy transition and sustainable technologies.

Market characteristics

- **Price Taker**: The copper price is set on international commodity exchanges. Copper producers cannot pass on cost increases to customers, and in particular have no ability to pass on higher electricity and CO_2 costs to customers because copper is a homogenous raw material with the same quality wherever it is produced. Copper sector is a price taker.
- **Revenues in the copper industry are largely independent from price discovery on LME and production costs:** Smelters' and refiners' revenues are based on treatment charge for copper concentrates and refining charge for copper blister, copper premium for copper cathode and surcharge for converting cathode into products. The treatment and refinement charges, which constitute the major part of the revenues, must be based on the applicable benchmark reference terms i.e. they are determined by the world market. These charges cannot internalize regional regulatory costs.
- **Market share:** Most smelted and refined copper production is happening in Asia. A large share of copper and copper alloy semi production has been installed in Asia as well. European production remains rather limited, and without establishing a level playing field, this trend is set to exacerbate**.**
- **Uneven distribution of output and demand:** While demand is globally expanding, the capacity expansion is exclusively happening in Asia. This imbalance is also happening due to the massive increase in demand for copper in China: China will account for 53% of demand growth globally, while the EU, with 7% of this demand growth, remains in a far lower range.
- **Trade patterns show a growing shift to outsource Cu production:** While demand for refined copper in Europe has been growing by about 12% from 2013 to 2017, this has not led to increased investments or outputs within the EU Copper industry. Production growth between 2013 and 2018 was only about 4.6%. Although net imports of total copper (NACE 2444) versus own production are moderate, (0.46% to 3%), smelted & refined copper net imports are substantial, and increasing from 20% in 2013 to 30% in 2018.

Profit margins

- **Exposure to indirect carbon costs/material impact on profit margins**: Profit margins are lower in the EU. EU companies shall cover all costs, including maintenance, auxiliary materials, wages, energy costs including indirect emissions cost with the same revenues as global competitors. This significantly reduces competitiveness. A recent study by the international consultancy Wood Mackenzie demonstrates that for the smelting processors, exposure to indirect emissions costs represents up to 26% of GVA, 25% of operating costs, 87% of operating margin and finally, 104% of profit margin at CO_2 price of 30 Euro/ton. These ratios may increase as a result of further electrification to decarbonize, as well as due to end of pipe filtration technologies, to comply with increasingly stricter environmental regulations in Europe, while competitors in non-EU countries do not face such policies and environmental restrictions. The resulting erosion of profit margins severely affects high-cost producers located in the EU. Supply contracts generally have terms of 10 years or longer. Copper smelters must estimate how long-term energy costs will develop, e.g. by 2030. If the copper sector is not eligible for indirect cost compensation, the EU smelters would not be able to sign long term contacts for copper concentrates, because the miners would not accept any CO2 related deductions which do not apply worldwide. A study for fabricators by European Copper Institute revealed that also for fabricators, the indirect emissions costs represent a significant share of the profit margin: at 30 € per ton CO2, it ranges from 20% for less complex copper /copper alloy products, to more than 75 % for semi production (sheets and strips), to more than 100% for complex copper alloy products such as brass profiles.
- **Treatment and refinement charges are driven by concentrate supply and copper demand:** Expansion of smelting capacities in China and low concentrate supply by miners let TC/RCs dwindle in recent years. Large differences in operating costs per ton of copper produced, triggered by regulatory costs, reduce the ability in Europe to invest further and internalize such regulatory costs.
- **Investment leakage:** The investment rate (Investment / Added value in %) in the EU copper sector has decreased steadily from 18% in 2014 to 14% in 2017. Companies are primarily investing in the modernization of the existing installations and implementation of the best available technologies, with significant share of the investments related to measures for environmental protection. No new plant has been built in the EU over the last decade. While European copper production did not show any significant growth, Asian copper production increased significantly: more than 5 times its output and more than doubled its market share from 27% in 1990 to 62% in 2017. Chinese smelters

planned to add 900,000 tonnes of annual smelter capacity in 2019 with another 350,000 tonnes due to come on stream this year. The planned expansion at smelters capacity by 2023 only happens outside Europe. Increased smelting capacity and output of semi-finished products in China are an indicator of investment leakage as growing demand did not lead to increase of production capacities in Europe. Without indirect emissions compensation, copper fabrication in Europe is not attractive for new investments. Some fabricators have already shut down operations and others face significant carbon leakage.

- **Carbon leakage**: Net imports of smelted & refined copper are substantial and increased from 20% in 2013 to 30% in 2018. This is an evidence of carbon leakage as the European copper production has a much lower carbon footprint than global competitors. This also explains the pattern of imports and exports. Net imported smelted and refined copper has increased in value from 2,723 mn Euro in 2013 to 4,035 mn Euro in 2018. Closure of some copper fabricators is a proof that carbon leakage is already present.
- **Cross-commodity distortions**: Copper competes with aluminium in certain applications like cables. Removing the eligibility of copper for indirect compensation would lead to higher competition distortion in the internal market and to a competitive disadvantage for copper, as the aluminium producers will be eligible for such compensation.

Abatement potential

- **Copper industry is electro-intensive:** The share of indirect CO_2 emissions for the whole sector (NACE Code 24 44) is 60 % on average based on Eurostat data , while industry data indicate for most of EU smelters, refiners and fabricators this share is 75% to 90% or higher.
- **EU Copper industry has implemented the best available techniques for energy efficiency as required in the NFM BREF:** The use of a flash smelting furnace for autogenous smelting of copper concentrates, waste heat recovery and oxygen enrichment are now a common practice. The heat and process steam supply is covered by waste heat to a great extent. Process heat is used to produce electricity in the companies and utilization of low temperature heat inside and outside the plants. All these measures contribute to reduction of carbon emissions.
- **Lower footprint**: The European copper production has much lower footprint than global competitors. The carbon footprint of the global average copper cathode is 4 t CO_2 and the acidification potential (SO_2 emissions) is 60 kg SO_2 (*based on cradle-to-gate life cycle assessment).* EU copper producers report **twice lower CO_2 emissions and only a third of the SO_2 emissions of the average global copper cathode**. A key reason for this lies in the high input of recycling materials, energy efficiency and lower emissions from purchased electricity.

- **Recycling and circular economy.** Around 50% of copper produced in Europe is from secondary sources. With decreasing quality of raw materials and increasing complexity, energy intensity of production processes is likely to go up. Recycling complex scrap may become infeasible without ETS-compensation. China implemented a ban for importing electronic scraps. If the European copper industry will be further replaced by Chinese smelters, recycling and circular economy will be endangered.
- **Limitations to further reduce electricity consumption**: In the EU copper sector, where the best existing technologies to reduce electricity consumption have been already applied, there is little scope for further reduction in indirect carbon costs and the risk of carbon leakage is thus very high.

Fuel and electricity substitutability

- **Heterogeneous production process**: The copper sector is heterogeneous. The share of indirect emissions varies significantly depending on the scale of operation, complexity of raw materials, production routes, product specialisation, deployed technologies and process configuration, level of integration and stage in the value chain. There is a small number of installations processing variety of raw materials. Smelted & refined copper production tonnage is about 30% of total copper as per NACE 2444. It represents the most energy intensive part of the sector with more than 80% of energy consumption (mostly electricity). The high variability between undertakings in the copper sector will lead to high risk on the fuel and electricity substitutability criteria.
- **Treatment between direct & indirect carbon costs and incentivising electrification:** Energy requirements to treat copper concentrates with increased amount of impurities and increasingly complex secondary raw materials will rise. Replacement of natural gas with electricity or by electrically produced hydrogen in some processes, such as fire refining or shaft furnaces for cathode melting would be possible. However, the increase in electricity costs related to the EU ETS would not support this shift due to the current compensation for direct emissions costs linked to fuel consumption. Unequal treatment of direct (free allocation) and indirect cost compensation in copper sector and lack of indirect cost compensation would block further investments in decarbonisation by electrification because it would undermine any planning security against rising electricity costs in the future.

About European Copper Institute:

Headquartered in Brussels and part of the International Copper Association, the European Copper Institute brings together the copper industry and its partners, to make a positive contribution to the UN Sustainable Development Goals and to support markets for copper. This by engaging both on regulatory matters and via market development programs, *working in close cooperation with our members and non-members, who represent the whole copper value chain (copper producers, smelters, recyclers and fabricators).*

ETS State Aid Guidelines Review
Application for Qualitative Assessment by Copper Smelters, Refiners and Fabricators (NACE 24.44)

European Copper Institute
Copper Alliance

Outline

Copper sector welcomes the possibility for a qualitative assessment. Copper production meets the indirect carbon leakage indicator of 0.2 required for eligibility and it is evaluated at medium risk of carbon leakage in the consultation report.

This document represents the application of NACE CODE 24.44 'Copper production (Smelting, Refining and Fabrication)' to be included in the list of sectors eligible for indirect cost compensation. It provides responses to the 4 criteria outlined in the consultancy report: 1) Market characteristics, 2) Profit margins, 3) Abatement potential and 4) Fuel and electricity substitutability. In addition, we provide details on two additional criteria: a) indirect carbon costs for the copper sector given that the Eurostat data used for calculating copper's exposure underestimate it, b) contribution of copper to the transition

Key messages

- **Strategic commodity:** Copper is a key material for the energy transition facilitating GHG emission reductions in numerous other sectors, from renewable energy systems, through energy efficient end-use appliances to electrified transport, heating and cooling systems. It is also a key material in battery production. Copper sector's non-eligibility will result in inability to support effectively and efficiently other market trends like E-mobility which is in the broader interests of the European car manufacturing.
- **Price Taker**: Copper price is set on international commodity exchanges. Copper sector is a ***price taker***. Copper producers cannot pass on cost increases to customers, and in particular have no ability to pass on higher electricity and CO_2 costs to customers
- <u>**Revenues in the copper industry are largely independent from price discovery on LME and production costs.** The revenues are based on a treatment charge for copper concentrates and a refining charge for copper blister, a copper premium for copper cathode and a surcharge for converting cathode into products. These charges are determined by the world market and cannot internalize any EU regulatory costs.</u>
- **Exposure to indirect carbon costs/material impact on profit margins**: Profit margins are lower in the EU. EU companies have to cover all costs, including energy costs and indirect emissions cost by the same revenues as global competitors, which significantly reduces competitiveness. A recent study by the international consultancy Wood Mackenzie demonstrates that for the smelting processors, exposure to indirect emissions costs represents up to 26% of GVA, 25% of operating costs, 87% of operating margin and finally, 104% of profit margin at a CO_2 price of 30 Euro/ton. If the copper sector is not eligible for indirect cost compensation, the EU smelters would not be in a position to sign long term contacts for copper concentrates, because the miners would not accept any CO_2 related deductions which do not apply worldwide. A study for fabricators by European Copper Institute revealed that also for fabricators the indirect emissions costs are significant as compared to their profit margin and, at CO_2 price 30 Euro/ton represent from 20% for less complex copper/copper alloy

products to more than 75 % for semi production (sheets and strips), and more than 100% for complex copper alloy products such as brass profiles. .

- **Investment leakage**: Increased smelting capacity and output of fabricated products in China are an indicator of investment leakage as growing demand did not lead to an increase of production capacities in Europe. The planned expansion at smelters capacity by 2023 only happens outside Europe. Without indirect emissions compensation, copper fabrication in Europe is not attractive for new investments. Some fabricators have already shut down operations in Europe and other face significant carbon leakage.
- **Carbon leakage**: Net imports of smelted & refined copper increased from 20% in 2013 to 30% in 2018 and this in spite of 12% increase in demand. This is an evidence of carbon leakage as the European copper production has much lower carbon footprint than global competitors. Closure of some copper fabricators is a proof that carbon leakage is already present.
- **Cross-commodity distortions**: Copper competes with aluminium in certain applications. Removing the eligibility of copper for indirect compensation would lead to higher competition distortion in the internal market and to a competitive disadvantage for copper, as the aluminium producers will be eligible for such compensation.
- **Copper industry is electro-Intensive:** The share of indirect CO_2 emissions for the whole sector (NACE Code 24 44) , is based on Eurostats data that wrongly estimate it at 60%, while industry specific data shows that for almost all EU Smelters, refiners and fabricators, this is within 75% to 90% or even higher.
- **EU Copper industry has implemented the best available techniques for energy efficiency as required in the NFM BREF.**
- **Lower footprint**: The European copper production has twice lower carbon footprint than global competitors.
- **Recycling and circular economy.** Around 50% of copper produced in Europe is from secondary sources. With decreasing quality and increasing complexity of the primary and secondary raw materials, energy intensity of production processes is likely to go up. Recycling complex scrap may become infeasible without ETS-compensation. This endangers the circular economy and European copper fabrication.
- **Limitations to further reduce electricity consumption**: In the EU copper sector sites, where the best existing technologies to reduce electricity consumption have been already applied, there is little scope for further reduction in indirect carbon costs and the risk of carbon leakage is thus very high. Not giving indirect emissions compensation will further undermine incentives to undertake electrification and resulting energy efficiency improvement.
- **Heterogeneous production process**: The high variability between undertakings in the copper sector in terms of product specialisation, production routes, deployed technologies, raw materials, and the use of gas and electricity in their production processes will lead to high risk on the fuel and electricity substitutability criteria.

- **Treatment between direct & indirect carbon costs and incentivising electrification:** Unequal treatment of direct (free allocation) and indirect cost compensation in copper sector and lack of indirect cost compensation would block further investments in decarbonisation by electrification because it would undermine any planning security against rising electricity costs in the future.
- **Delivering upon the Green deal:** Achieving a climate neutral and circular economy will require a competitive EU industry. Compensation of the indirect cost for the EU Emission Trading System, is essential for the EU copper industry to continue contributing to the objectives as foreseen by the new European Green Deal on a level-playing field with other materials and with Non-EU regions.

1. Additional Considerations not included in the criteria used to access to carbon leakage risk in the Consultancy Report

I. Copper is important for the Green Deal and the transition to a climate neutral economy.

Copper is a strategic material for the transition to a climate-neutral economy.

Because of its excellent electrical and thermal conductivity, copper plays a vital role in most decarbonisation solutions. In short, there can be no electrification without copper. Copper facilitates the production of renewable electricity as well as the electrification of transport, heating and cooling. **It is also a key material in battery production**. Its properties make it the conductor of choice for wires, cables and electrical equipment. Increasing the cross-section of electrical conductors reduces energy losses, which is the reason why energy efficient electrical connections and appliances are generally more copper intensive.

- Copper plays an important role in renewable energy generation – such as solar, wind, tidal, hydro, geothermal – by converting renewables into electricity or heat. In addition, the obvious trend towards distributed generation and a decentralised system relies on more storage and increasing demand side flexibility solutions, which often rely on copper-based technologies. Copper will be a crucial metal for the energy transition (https://www.eurometaux.eu/metals-blue-print-2050/ Page 30). By 2027, more than 100,000 tonnes of copper will be needed to build 40 million charging points for electric vehicles coming on the market (page 61). Solar panels will require 3 ton Cu / MW installed, wind turbines would demand 3.5 ton Cu / MW installed, and efficient grids, interconnectors, subsea grid would need more than 400,000 tons Cu over next decade (page 62).
- A low-carbon future is not possible without smart and connected electrical and thermal grids. Copper is a key metal to making these grids smaller, smarter, more flexible and more energy-efficient. For every kg of copper used in a motor, 3 less tons of CO_2 are produced, and for every kg of copper used in a transformer, 0.5 less ton of CO_2 is produced. A tonne of copper in electrical systems could deliver a lifetime savings within the range of 100-7500 tonnes of CO_2.
- Buildings are gaining importance as an active component in the transition towards smart energy systems – providing demand flexibility and hosting increased renewable energy source (RES) capacities. For a building to become smart and connected, it needs copper.
- Beyond the energy sector, copper is a key component in new, low-carbon modes of

transportation, such as electric vehicles, playing an important role in their batteries and control systems as well as the charging infrastructure.
- In industry, the increasing share of renewables in the energy mix opens up a large potential for electrification of heat processes.
- In the heating and cooling sector, copper lead to cost-effective reductions in energy use in the range of 20-30% thanks to its excellent conductivity

Copper is a key material in battery production

Copper is used as current collector at the anode of lithium cells and widely used for the components of the battery management system. Copper companies are key members of EU battery initiatives such as the Battery Alliance and advocate strongly for identifying batteries as a key strategic value chain. According to the ecodesign study for batteries, Cu represents between 6.5% and 11.5% of the cell weight. There is indeed more weight of copper than lithium in a battery. Ref: https://ecodesignbatteries.eu/files/attachments/ED_Battery_study_Task4_final%20draft.pdf . Table 4.

As establishing a battery value chain is an Important Project of Common European Interest (IPCEI), and thus is considered of strategic priority, it is also necessary to take into account the provision of raw materials to achieve the objective of building a sustainable and competitive battery value chain.

Copper contribution to resource efficiency

Copper is an important carrier metal that enables the recovery of many valuable metals needed for today's energy transition and sustainable technologies. EU copper smelters produce copper, and in addition recover many valuable metals such as gold, silver, lead, nickel, tin, platinum, palladium from the same primary and secondary raw materials mainly containing copper. The production of these metals as a by-product is only possible through competitive copper production, as copper is the carrier of these other metals. If competitive copper production would no longer be possible in Europe because of too many barriers, this will eliminate the current precious metal source and the EU's capacity to produce and supply essential and valuable metals would be diminished.

II. The quantitative criteria used by the European Commission in their calculations underestimate the copper sector exposure

The copper sector is electro-intensive and highly exposed to carbon leakage. Exclusively quantitative criteria significantly **underestimate the actual copper sector's "carbon leakage" risk:**

- First, copper is a 'price-taker' commodity produced by companies operating in highly competitive global markets, with prices set at global exchanges – as evidenced by the letter from the London Metal Exchange in attachment. This means that copper producers have no influence on the copper price and are not in a position to pass any local regulatory costs, such as the EU ETS indirect costs, to their customers. The trade intensity criterion **does not sufficiently reflect exposure of the European copper industry to this international competition**.

- Second, a recent study by the international consultancy Wood Mackenzie demonstrates that at a price of 30 €/t of CO_2, **European copper smelters face**

indirect emissions costs up to 26% of GVA, 25% of operating costs, 87% of operating margin and finally, 104% of profit margin (Annex 3)

- A study conducted by European Copper Institute demonstrates similar results for fabricators. In fact, some of the European fabricators have shut down and others face indirect emissions costs to profit margin ratios of between 20% for simple copper alloy (brass) products and to more than 100% for complex copper alloy products. (Annex 5)
- The copper sector is also heterogeneous and the share of indirect emissions varies significantly depending on the complexity of raw materials, production routes, deployed technologies, level of integration, and stage in the value chain. In addition, the electricity used for oxygen production (24-40% of total electricity use by copper smelters) is not included in the calculated emission intensity of the sector.

Copper sector welcomes the possibility for the qualitative assessment. Copper production meets the indirect carbon leakage indicator of 0.2 required for eligibility and it is evaluated at medium risk of carbon leakage in the consultation report.

2. Criteria to assess carbon leakage risk in Consultancy Report

I. Market characteristics

a) Price taker

Copper industry is a price taker

The EU copper industry is part of a global industry, which is open and highly competitive. International trade in raw materials and copper cathodes is an important aspect of this global industry. The highly globalised nature of the industry is reflected clearly in price setting mechanisms: **prices for raw material inputs and copper cathodes are set or referenced through the London Metals Exchange (LME).**

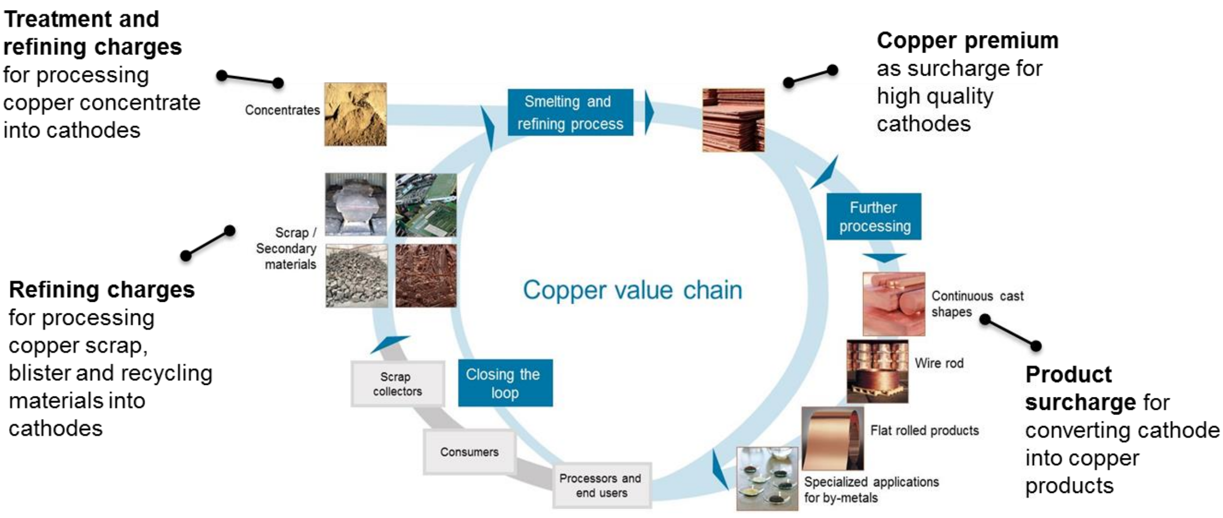
Copper industry is electro-intensive and a price-taker on global markets. The indirect costs contained in the electricity price have a considerable impact on competitiveness and investment. The prices for copper are determined globally on the London Metal Exchange (LME), while cost factors (outside raw material inputs) are determined locally, making them important determinants of copper smelters' competitiveness. Non-EU regions do not have to absorb the costs of emission trading. These costs are not reflected in global prices for copper and relate solely to the cost structure of European producers that have only a small global market share. In Annex 1, we provide a letter from LME proving our price-taker status.

Copper producers cannot pass any additional costs, including costs of the EU ETS, on to downstream customers because copper is a homogeneous raw material with the same quality wherever it is produced. This creates a cost disadvantage compared to non-European competitors and potential for carbon leakage. In order to compete, the EU industry continuously increases its efficiency. However, this is approaching the limits of technical possibility.

The copper industry – understanding the business model

Copper smelters process copper concentrates that are obtained from ores and offered by mining and trading companies on the global market. Concentrates are sold by mines at the world reference market price of the metal amount contained minus a Treatment and Refining Charge (TC/RC). Miners and smelters negotiate these TC/RC. The TC/RC trend depends on the current supply and demand structure on the global markets. The lower the concentrate supply, the more bargaining power mining companies have vis-à-vis smelters; the higher the available smelting capacity, the lower the bargaining power of smelters gets vis-à-vis miners.
The business development is also influenced by external factors. These include the economic performance in key countries and activities on the international financial markets; the political, legal, and social conditions; changes in the exchange rate and interest rate level; and the situation on our relevant markets. The treatment and refinement charges must be based on the applicable benchmark reference terms. This benchmark is announced for the reference year on the basis of reported contracts between large copper mines and independent copper smelters in Europe, Japan and China. **This means the world market determines how high the refining and treatment charges are in Europe.**

The copper industry – metal prices and processing costs
Smelters and refiners buy or treat ores and concentrates at the global reference price of the contained metal and also sell their product at the global reference metal price. In contrast, cost factors (outside raw material inputs) are determined locally. Fabricators buy the copper cathode based on the global reference price and receive a surcharge for converting cathodes into products. Operating costs are not linked to the metal price. Companies try to control the costs, whereas they have virtually no control over the revenues. The competitiveness of the copper industry is determined by processing revenue (treatment charge for copper concentrates and refining charge for copper blisters, surcharge for converting cathodes into products) minus the operating cost, including energy and indirect emissions costs. The processing revenues cannot be hedged and are determined by marketing forces balancing supply from mines, smelting and refining capacity and supply from secondary copper containing materials.
Turnover of smelters is high, yet profits rely overwhelmingly on TC/RCs, which fluctuate independently of the metals price. (Source : The official LME guide to managing metals price risk)

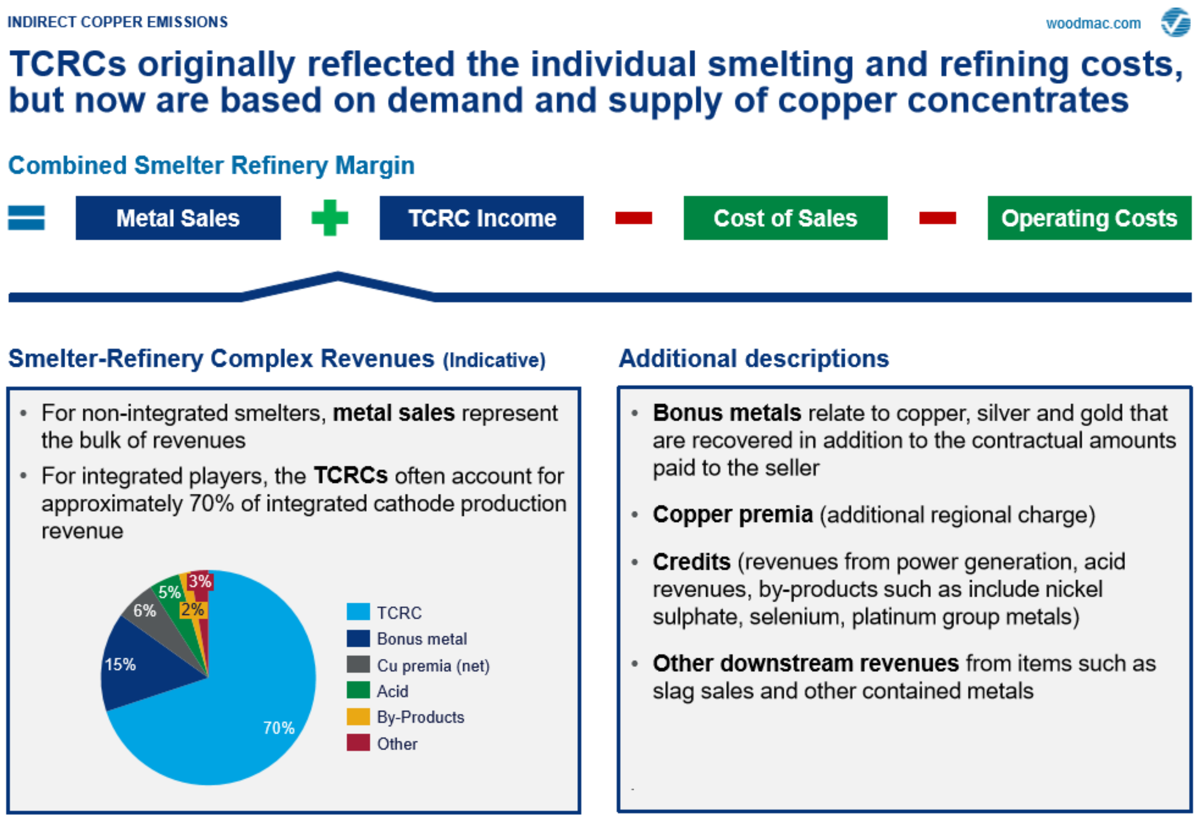


About 45 % of feed supplies to the EU copper refineries are purchased on the international market in the form of copper concentrates, blister, anodes or scrap. The remaining 55 % come from EU-produced copper concentrates, copper-bearing residues and scrap [NFM BREF chapter 1.2.3].

European copper smelting and refining activity has been able to operate primarily by securing raw materials on the international market and by making use of 'domestic mining'. This consists of copper scrap and residues generated by consumers and processors, as well as by building demolition and end-of-life waste (e.g. vehicles, electric and electronic waste). Access to primary and secondary supplies has become increasingly difficult. This has partly been due to copper mining countries developing their own smelting and refining facilities, but mainly due to much stronger competition from countries such as China and India, seeking copper raw materials to meet the needs of their rapid industrialisation. [NFM BREF chapter 1.2.3].

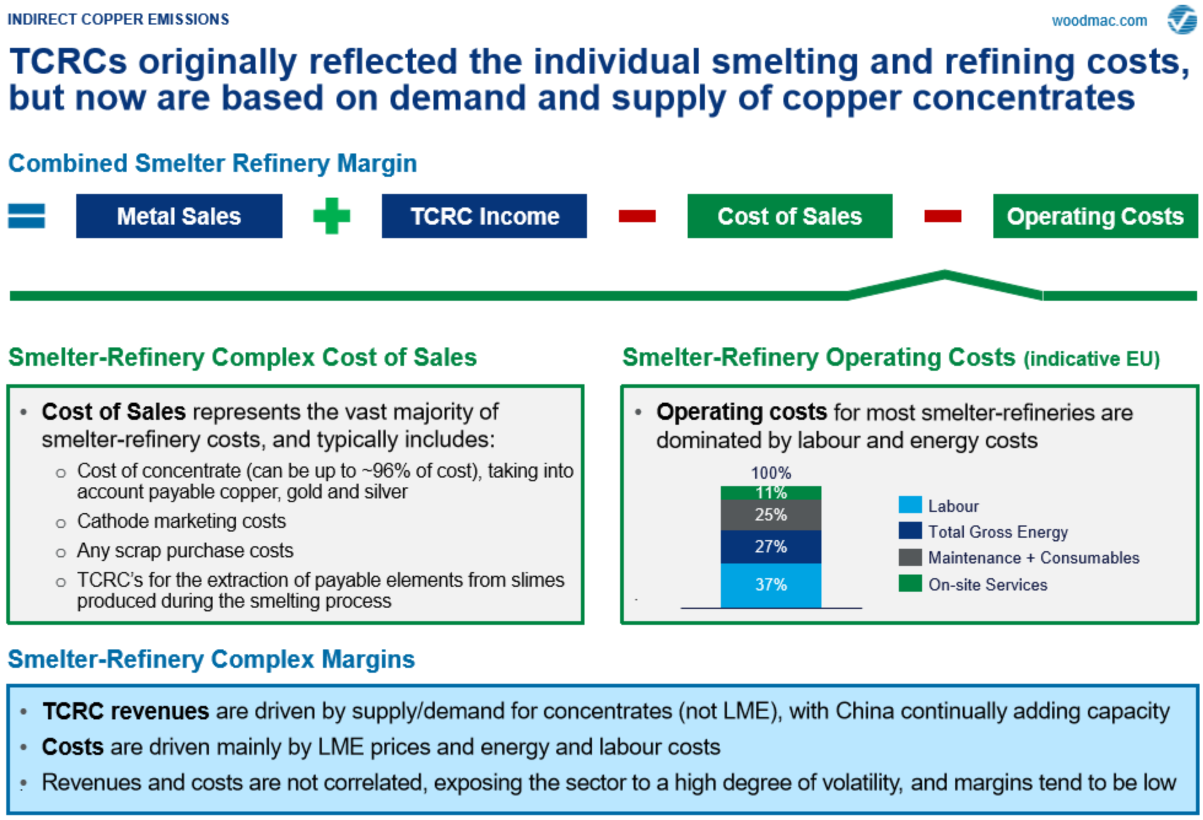
Consultancy Wood Mackenzie has illustrated the revenue and cost model of copper smelters and refiners based on treatment charges and refining charges (TC/RC).
Please refer Annex 4.

Revenue Model for Smelting and Refining



ETS State Aid Guidelines Review
Application for Qualitative Assessment by Copper Smelters, Refiners and Fabricators (NACE 24.44)

Cost Model for Smelting and Refining:



Applying the 2012 criteria to assess if a sector is a price taker

In the 2012 Guidelines, the European Commission verified that a sector was a price-taker if it met the following 5 criteria:

1. Commodities with globally-set prices traded on global commodity exchanges such as the London Metals Exchange or other global pricing mechanisms:

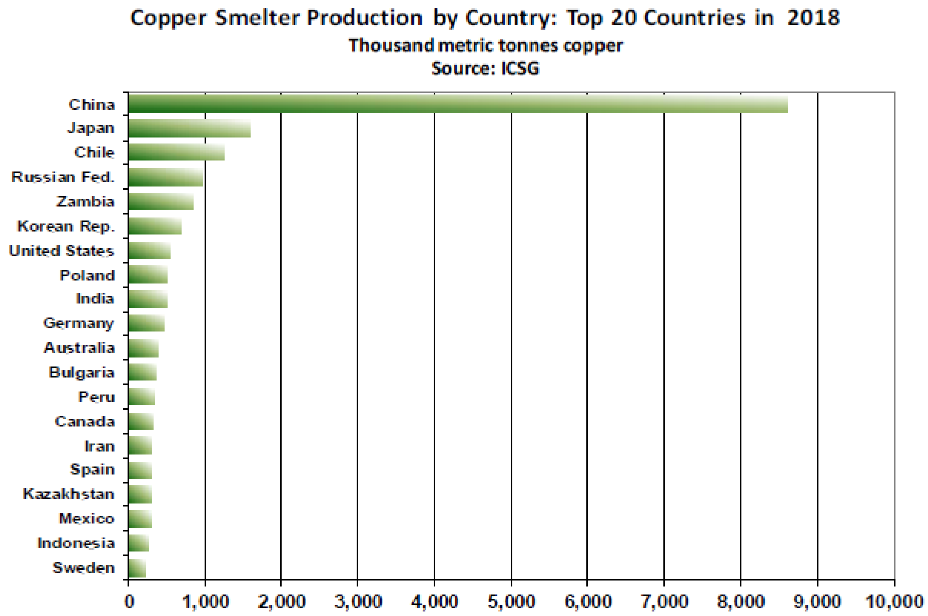
   Price for copper cathode is set or referenced through global commodity exchanges such as the London Metals Exchange (LME).

2. The price elasticity of demand: If high, it gives no possibility to pass through costs, and even a small price increase would impact negatively the market share.

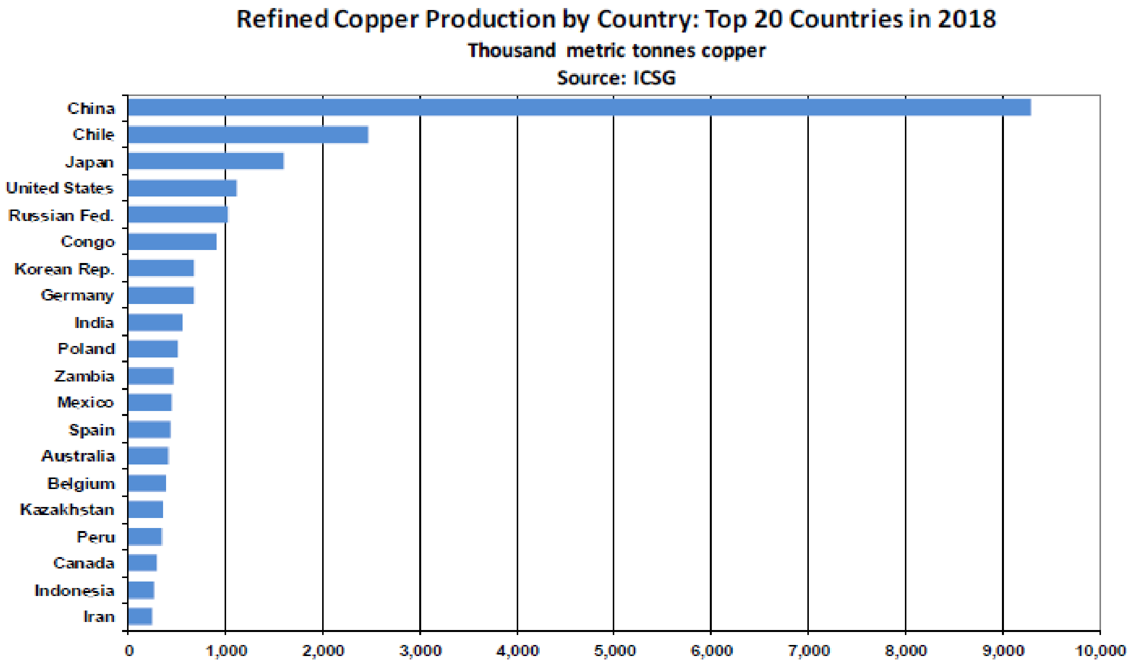
   Copper is traded on international exchanges at prevailing global market prices. It thus demonstrably has little opportunity to pass on additional costs, for which reason the price elasticity of demand is extremely high. The slightest price increases have a massive impact on the purchasing decision of consumers, so the smallest cost differences can trigger shifts

3. Global market share: With globally-set prices and relatively low global market share of the European production, European copper producers are price-takers, and cannot pass through any carbon costs.

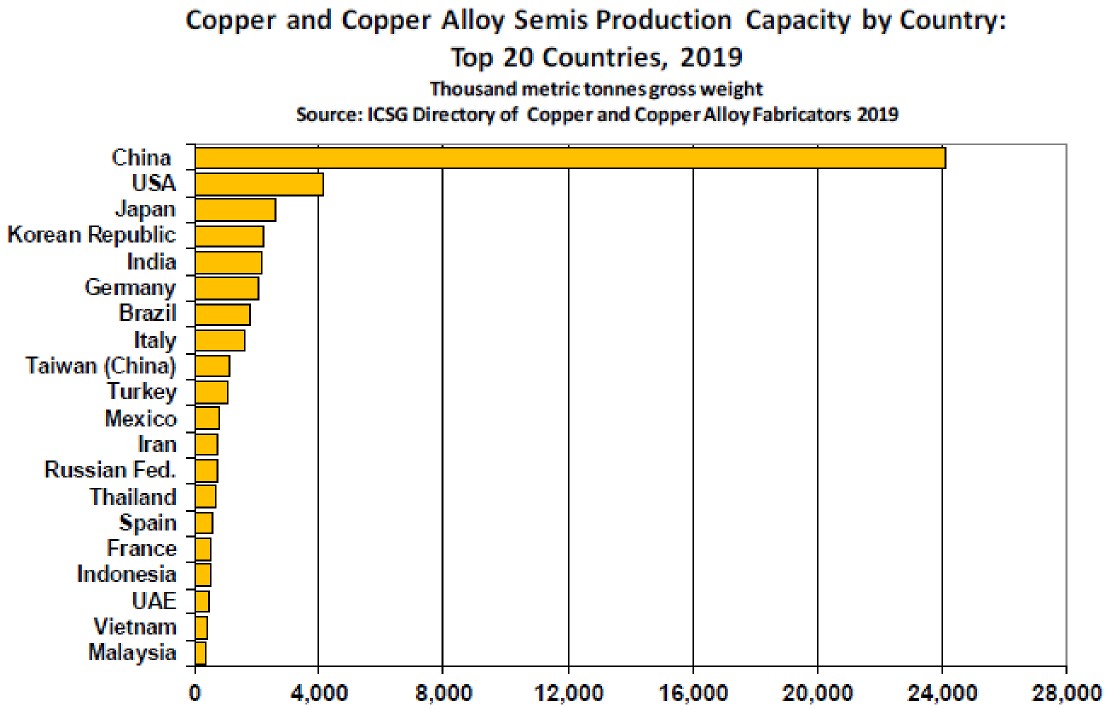
   EU copper production has relatively small global market share.



In 2018, China accounted for over 40% of world copper smelter production, followed by Japan (8%), Chile (6%) and Russian Federation (5%).



In 2018, China accounted for 39% of world copper refined production, followed by Chile (10%), Japan (7%) and the United States (5%).



4. Homogeneity of the product: Homogeneous products meet high global competition and cannot pass through any carbon costs.

Copper cathode is a homogenous material with the same quality wherever it is produced. All brands approved for good delivery against LME contracts must conform to strict requirements on quality, shape and weight, as outlined by the exchange (e.g. BS EN 1978:1998 Copper Cathodes (Cathode grade designation Cu-CATH-1).

5. Low transport costs: Low transportation cost share of production value cannot pass through any carbon costs.

Transport costs for Copper is in the range of 0.5 to 1 % of the LME price for copper, currently at approximately 6.000 USD per tonne. Furthermore, with LME warehouses being present close to industrial consumption locations all over the world, this does not form a barrier to entry for non-EU competitors or to stop EU production and import from outside.

b) Link between cost and output price

Because of the specific market structure of the copper sector, output prices are not relevant. The smelters / refiners are paid a processing fee, which depends upon the ratio between the mining output and the smelting and refining capacity. **This is independent of price discovery on LME**. Thus, the profitability of our business does not depend on the fluctuations of the metals price. This also means that production costs have no real impact on output prices as the price-finding happens independently from production costs. As the metals value is passed through to the customer, fluctuations in output prices are a function of the price-discovery at the LME, and doesn't take into account the production costs incurred. (Source: The official LME guide to managing metals price risk)

Import prices are also set by the value of the metal content according to LME pricing. This, however, is not relevant for the profitability of the company as this metal value is passed on along the value chain to the final consumer. Thus, while import prices may fluctuate according to the price setting at the LME, their relevance for the profitability of smelters is limited as the profitability depends on TC/RCs, and thus on the availability of a) concentrates and b) global smelting capacity.

c) Bargaining position

Eurostat data for NACE code 2444 shows a decline in the number of companies by 11,8% since 2009.

GEO/TIME	2009	2010	2011	2012	2013	2014	2015	2016	2017
European Union - 28 countries (2013-2020)	387	347	344	376	384	329	338	327	306

However, smelters and refiners as well as semi-fabricators are far fewer companies: there are seven smelting and refining companies, and about 80 semi-finished goods fabricators.

Refined copper is produced from primary and secondary raw materials by a relatively small number of smelters and refiners (7 companies), their final product is copper cathode. This is melted, alloyed and further processed to produce rods, profiles, wires, sheets, strips, tubes, etc. (so called semis manufacturing). This step may be integrated with the refinery but is frequently carried out at another site. Far more companies participate in the copper semis manufacturing industries also called fabricators. About 80 companies, throughout the EU-28, produce copper and copper alloy rods, bars, wires, sections, tubes, plates, sheets and strips. About 30 companies in this sector have integrated foundries for the production of cakes, billets and other primary shapes for further processing. The others purchase these either from the smelters/refiners or from other semis manufacturers [Ref. NFM BREF[1], chapter 1.2.3].

Given the cost and pricing structure of the sector as described above, the bargaining position is – despite the small number of companies – limited. Downstream processor pays upstream the metal price to their suppliers, while profitability depends on the TC/RCs negotiated between smelters and mines or on the processing premiums between fabricators and scrap owners.

Scalability and size is important to survive as barriers to entry are very high as shown in the modelling of Dixit and Pindyk (1993). Thus, the size of a company is a condition for being operational, and not necessarily a boost to bargaining power. This also accounts for the limited numbers of deaths and births of companies in this sector – neither entering nor exiting is an easy task due to the high barriers. Nevertheless, closure of some of the fabricators such as, MKM (Brass) in UK, BCZ (Tubes) in Belgium, LDM (Brass) in The Netherlands is a proof that carbon leakage is already present.

As product value is determined by the metals price, which is independent from the profitability of a smelter, this number is misleading. As copper has quite a high value, production values including metal price are generally high, yet this is passed through from

[1] Best Available Techniques (BAT) Reference Document for the Non-Ferrous Metals industries

the mine to the buyer and thus doesn't adequately reflect the income stream of a company.

d) Existing and future trade patterns

Trade Patterns
According to Eurostat Prod Com data (24441200 and 24441330) as well as DG Trade data (tariff heading (HS-system) 74 (copper products)) there is a clear pattern indicating that the value of imports are on the rise both in quantity as in value while export quantities are rather declining.
Demand for refined copper has steadily increased by about 12% from 2013 to 2017, yet this demand increase has not led to increased investments or outputs within the EU Cu industry: actual production has increased modestly from 7,776 to 8,139 kton Cu, i.e. cumulatively about 4.6% from 2013 to 2018 (Annex 2).

Projected absolute demand growth in Europe with 7% is in the lower mid-ranging field as compared to China where 53% of the global demand growth is concentrated.

See also Section II, b, Projection of demand in the EU and outside
(Source: Study provided by CRU and published by the in 2019 by the department of Energy and Mining of the Australian government (http://energymining.sa.gov.au/__data/assets/pdf_file/0004/344209/Erik_Heimlich.pdf),
This also explains the pattern of imports and exports. Net imported smelted and refined copper has increased in value from 2,723 mn Euro in 2013 to 4035 mn Euro in 2018 (Annex 2).

This is also evidenced by stagnating numbers of production value and value added at factor cost.

Production value:

GEO/TIME	2011	2012	2013	2014	2015	2016	2017
European Union - 28 countries (2013-2020)	41,974	38,759	34,744	33,891	33,955	32,108	38,585

Value added at factor cost:

GEO/TIME	2011	2012	2013	2014	2015	2016	2017
European Union - 28 countries (2013-2020)	3,683.1	3,567.3	3,069.6	3,370.2	3,346.3	3,539.0	3,953.7

This is evidence of carbon and investment leakage as by importing copper from other parts of the world, the EU imports CO_2 which could have been avoided if investments had been possible to expand capacity to meet higher levels of demand.
Given that imports of total copper (NACE 2444) over own production are small, the trend clearly shows a substantial relative increase of smelted and refined copper net imports by 20-30% – a trend that is likely to become more pronounced given future demand projections. This also shows a growing penetration of imports (Annex 3).

II. Profit margins

a) Current situation: Profit margins, Investments in the sector, products substitutability

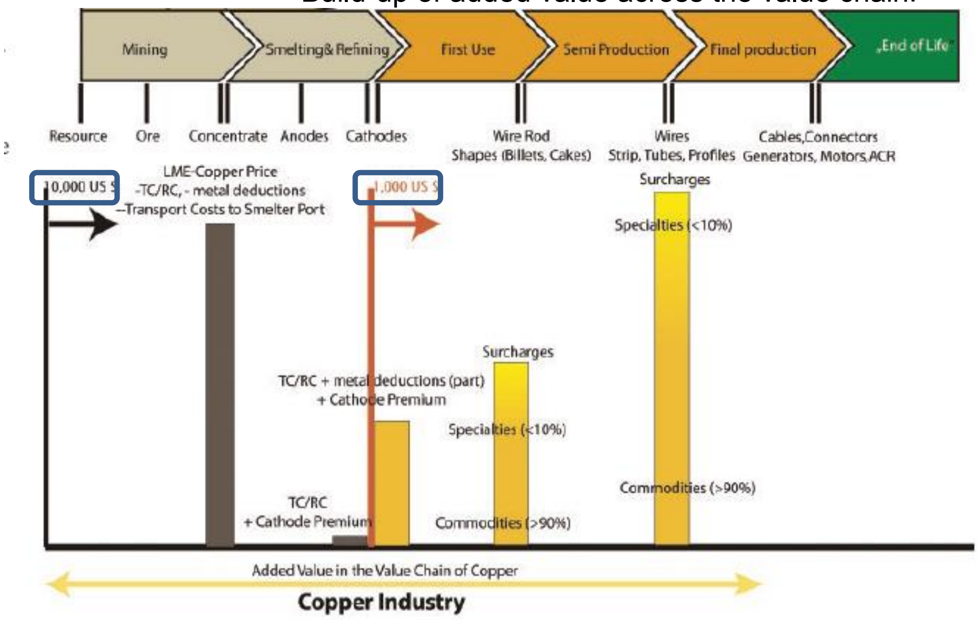
Profit margins are lower in the EU

Copper industry is very fragmented, split in many processing steps, which belong to different companies. This contrasts with the aluminium and steel industries, which are fully integrated and where the mining companies also produce semis. The copper companies are mainly specialised either on mining, smelting and refining, or producing semis. One reason for that is the cathode. In contrast to aluminium or steel where the final product of refining is liquid metal melt , which can be cast directly into billets or cakes, copper cathodes are transported and traded , and have to melted for further processing. Also a lot of new copper scrap arising from the manufacturing of copper products is often given back to the supplier for re-melting or refining. **Therefore, the companies operating at different steps of the value chain are interlinked.** (*Source: Understanding copper, Technologies, markets. business, Bernd Langner)*

The prices of refined copper are determined in the global market. The LME registered copper cathode is the base for all calculations of price, cost and revenues in the value chain. Smelters pay for its raw materials in accordance with the respective copper cathode price for copper content on the metal exchanges (LME) less a treatment and refining charge. Fabricators pay for the copper cathode based on LME price and get a get a surcharge for converting cathodes into products. Access to primary and secondary supplies has become increasingly difficult. This has partly been due to copper mining countries developing their own smelting and refining facilities, but mainly due to much stronger competition from countries such as China and India that are seeking copper raw materials to meet the needs of their rapid industrialisation.

LME copper prices are used to **value copper in the whole chain** from mining to smelting & refining to fabrication. **The “LME price” does not reflect or internalize indirect emissions costs.** In the copper industry the revenues and burden are shared unevenly along the value chain. This is well illustrated in the below graph. Please note that that there is a different scale of the graph for the mining and smelting part (10,000 USD) and the copper fabrication part (1,000 USD).

"Build-up of added value across the value chain."



It can be seen that most of the revenues are obtained by the mines for which the revenues are basically the LME price of copper content minus treatment and refining charges to be paid to the smelter. The revenues for processing of concentrates to cathodes and further on to products **are an order of magnitude lower**, as evidenced by the change of scale in the graph**.** Whereas the mines have the big advantage from high copper price, the semi producers have much higher financing costs for the purchased cathodes at high copper price without getting much more added value. It could also be observed that new market players are pushing into market by offering e.g. wire rod at the same price as cathodes (so without surcharge) as they cover their costs by previous productions steps. (*Source: Understanding copper, Technologies, markets. business, Bernd Langner)*

EU companies shall cover all cost, including energy costs and indirect emissions cost by the same revenues as global competitors, which significantly reduces competitiveness. **The resulting erosion of profit margins severely affects high-cost producers located in the EU.**

<u>Smelters and refiners</u>

Smelters and refiners produce copper cathodes from concentrates and scrap by smelting , converting , fire refining and electrolytic refining. Smelters and refiners revenues are fixed based on treatment charge for copper concentrates and refining charge for copper blister as well as copper premium. These treatment and refinement charges must be based on the applicable benchmark reference terms. This benchmark is announced for the reference year on the basis of reported contracts between large copper mines and independent copper smelters in Europe, Japan and China. **This means the world market determines how high the refining and treatment charges are in Europe.**

<u>A practical example for a smelter/refiner</u>

Primary copper smelter, processing copper concentrate in 2017 with average copper content 27%.

The indirect cost at carbon price of 30 Euro per ton of concentrate is **13** USD / ton.

The operating cost of the smelter per ton of concentrate is 117 USD / ton.

Treatment charge (TC) is 79 USD / ton concentrate (published benchmark Bloomberg 2017).
Refinement charge (RC) is 174 USD / ton copper (published benchmark Bloomberg 2017).
Premium is 86 USD / ton copper.

The calculation of the revenues per ton of concentrates is as follows:

Revenues / ton concentrate = 79 + 174*27% + 86*27%*98% = 148,7 USD
Profit margin / ton concentrate = 148,7 - 117 = **31.7** USD

Indirect cost / Profit margin = 13 / 31.7 = **41 %**

If the copper sector is not eligible for indirect cost compensation, the EU smelters would not be in a position to sign long term contacts for copper concentrates, because the miners would not accept any CO_2 related deductions which do not apply worldwide.

<u>Copper wire rod</u>

Copper wire rod is the most important first use of copper cathode. As the production and properties of wire rod is very sensitive to impurities, almost exclusively copper cathodes are used. Wire rod is a real commodity, as it is standardised and traded all over the world.
The biggest cost factor in rod production after labour is energy, mainly for the melting of cathodes, and for the rolling of cast bar, although the processes have optimised in the last years to lower the energy consumption. The melting in shaft furnaces consumes the higher part of the energy in form of natural gas. Electricity is consumed for rolling. The wire rod production has a high share of the natural gas consumption in the value chain (see section IV b) . Because there are no major steps in new technologies expected, and the cathodes must be always melted in the first step, the rising energy costs are an important factor for the global competition.
The revenues are related to surcharge for converting copper cathodes into rod. The surcharges for copper rod are only 2–5 % of the copper price. Financing costs for copper cathode stock, especially for standalone plants is an important factor. (*Source: Understanding copper, Technologies, markets, business, Bernd Langner)*

<u>A practical example for wire rod production</u>

A typical wire rod plant emits 0,06 t CO_2 per ton of product.

The indirect cost at carbon price of 30 Euro per ton of product is **1,8** EUR / ton.

The operating cost of the plant per ton of product are **79,4** EUR / ton.

The revenues per ton of product of **91** EUR / ton are market based as wire rod has as described a commodity character.

The indirect CO_2 costs have a share of **16%** of the margin.

As the wire rod production has a high share of natural gas consumption the production is in focus for decarbonisation e.g. by hydrogen. In case of 40% hydrogen enrichment the electricity consumption to produce green hydrogen would cause further 33.240 tons of indirect CO_2 emissions. The indirect cost of carbon would rise to 5,8 EUR / ton, what is almost 50% of the margin. Therefore, by enrichment to 80% hydrogen or carbon price increase to 60 EUR / ton the profit is negative.

<u>Copper semis products</u>

Copper cathodes and copper scrap are used for production of shapes (billets and cakes), which are further processed into strips and tubes by rolling and drawing. In the copper semi industry there is a big variety of different products, which differ by the chemical composition of different alloys, by mechanical and thermal treatment, by width, thickness or surface treatment.
The revenues are related to surcharge for converting the cathodes into products. For strips in commodity quality the surcharges have been around 1000 euros/ton.
The prices have to cover the operating cost, the financing costs and the cost for scrap.
The operating cost includes cost for casting, hot rolling or hot extraction, cold rolling or drawing, annealing and slitting. The main cost factors are energy and labour.
An important cost factor is scrap. Especially in the strip production, but also in the production of tubes and profiles the scrap rates are high. For example in strip production the scrap rate from cathode to strip can be as high as 40 – 50%. In the further steps more scrap is produced so in the final application only 20-30% of the originally produced copper or copper alloy can be found.
Another important factor for producing semis is financing the copper stocks. In strip production the time of production may be 4 weeks or even more, during which copper has to be financed. Then the recirculating scrap also has to be financed even over longer time depending on the product and scrap logistics. So, the semis fabricator not only has to finance its margin or cost but also the copper which it must buy at LME price.
In the production of strip production time is very long. Also stocks of raw materials are high mainly because of high amount of scrap produced during processing, but also because of a large number of different products. This indicates that the financial burden for semis producers is very high. For a strip producer including stocks and processing time, the time to finance is about 100 days and more with an added value which is for some products often no more than 500 USD /t. The financing cost may be one third of the added value.
The relatively long delivery times for semis products have an additional effect. Due to the complexity of semis products they are produced on demand, however small changes in economic situation has multiple effect on the term short demand by customers.
Energy costs have important influence on the competitiveness of the semis production, and especially in relationship to the relatively low profit margins they are even more important than for other steps of the value chain. (*Source: Understanding copper, Technologies, markets. business, Bernd Langner)*

A practical example for semis production

An average semis fabricator emits 0.5 tons CO2 per ton of product.

The indirect cost at carbon price of 30 Euro per ton of product is **15** EUR / ton.

The operating cost of the plant per ton of product is **1280** EUR / ton.

The revenues per ton of product are **1300** EUR / ton.

The indirect CO_2 costs have a share of **75%** of the margin. Therefore, without compensation the indirect carbon costs are exceeding the profit from 40EUR / ton like for the highest exposed sectors (e.g. Aluminium).

This high exposure to carbon leakage is presented in the study commissioned by the European Copper Institute to the international consultancy Wood Mackenzie. This analysis for the period 2017 – 2019 shows that at a price of 30 €/t of CO_2, copper sector's upstream part -namely smelting and refining, is highly exposed to indirect emissions costs. **Smelting processors exposure to indirect emissions costs represents up to 26% of GVA, 25% of operating costs, 87% of operating margin and finally, 104% of profit margin (*Annex 3*).** These ratios may increase as a result of further electrification as well as of end of pipe filtration technologies to comply with increasingly stricter environmental regulations in Europe, while competitors in non-EU countries do not face such environmental restrictions.

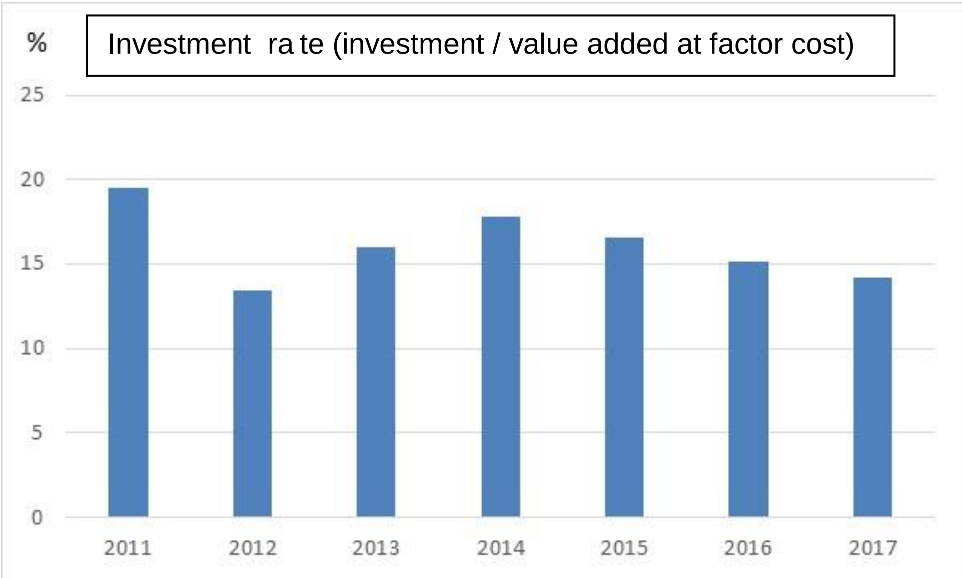
The fabricators of copper products are also significantly exposed to a risk of carbon leakage. ECI has collected electricity and profit margin data on representative products of the different Prodcom Codes: 24442200 , 24442330 , 24442350 , 24442370 , 24442400 , 24442500 , 24442630 , 24442650, from different member states in the Nordic region, CWE region, Iberia and Greece.

Profit margins of some of the fabricated products have even negative values because of fierce competition and decreasing processing revenues by scrap owners and due to imports to EU from third countries with no CO_2 taxes etc. In fact, at 30 € per ton CO_2, indirect emissions costs are from up to 20 % of the profit margin for some brass products and exceed profit margins completely for other brass products. For copper tubes and copper extruded products it is in the range of 5 -15%. Indirect CO_2 costs for wire rod production represent around 16 % of the profit margin. For semi production (sheets and strips) the indirect cost can be 75 % and more , even negative for specific locations. (see Annex 5)

It is obvious that at such a high exposure the copper industry cannot absorb an increase of the indirect emissions costs and still remain competitive.

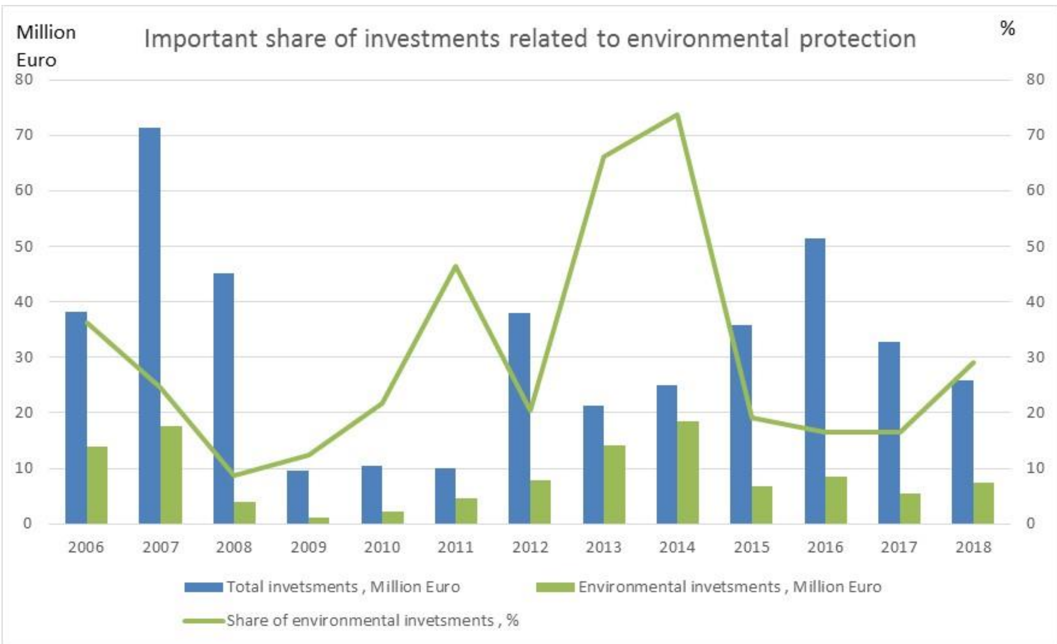
Investments in the sector

The investment rate (Investment / Added value in %) has decreased steadily from 18% in 2014 to 14% in 2017 (Annex 2)

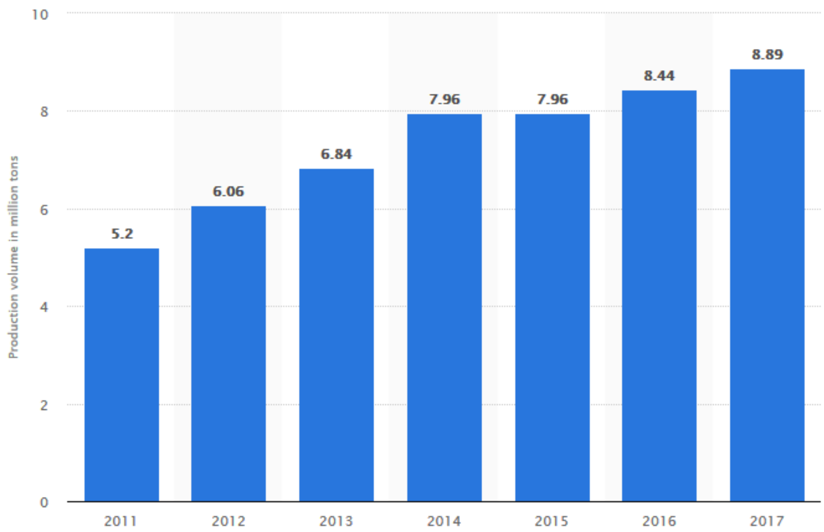


Companies are primarily investing in the modernization of the existing installations and implementation of the best available technologies. No new plant has been built in the EU in the last decade.

Significant share of the investments is related to measures for environmental protection (see below example, primary smelter).



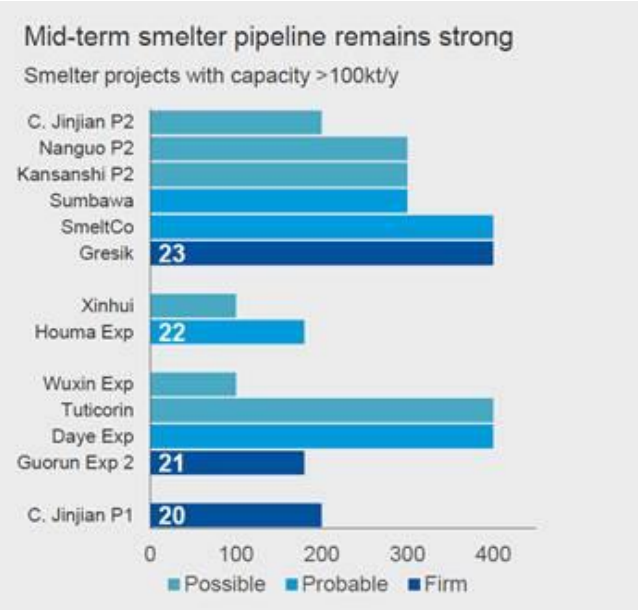
However, when looking at the development of smelting capacity in China, it becomes clear that the expansion of the sector is significant.



Chinese copper production value in Mio.t.

Chinese smelters are set to add 900,000 tonnes of annual smelter capacity in 2019 with another 350,000 tonnes due this year, according to China's state research house Antaike. There are plans for refinery capacity increases of 3 million tonnes of copper, while electrolytic refinery capacity is supposed to keep growing at a rate of 3.2%/year until 2021.

The planned expansion at smelters capacity by 2023 only happens outside Europe (source CRU)



In a global perspective, this trend is reflected in increasing investments in capacities, yet not in Europe, whose capacities despite growing demand remains unchanged.

Increased import of finished parts made of copper from outside EU put additional pressure on the EU copper fabricators. Essentially, scrap owners are from time to time inclined to get the scrap processed out of Europe, with less stringent environmental norms and no indirect emissions costs. Without indirect emissions compensation, and given the stricter environmental regulation, the fabrication of copper products in Europe is not at all attractive for new investments. Hence, the industry is suffering further and the capacity of the European copper industry is going down. The closure of some of the fabricators such as, MKM (Brass) in UK, BCZ (Tubes) in Belgium, LDM (Brass) in The Netherlands is a proof that carbon leakage is already present.

Substitutability with other products

Copper has the highest electrical conductivity of all non-precious metals. Its properties make it the conductor of choice for wires, cables and electrical equipment, which represents about two-thirds of copper use. Copper also conducts heat much better than other metals, which is highly important for heat exchangers and heat sinks in electronic components. Higher electrical conductivity means higher energy efficiency, or for the same efficiency, it means more compact designs.

Despite copper's outstanding performance, substitution of copper by aluminium during the last decade has been important due to the higher copper price. According to estimates by the International Copper Association, between 2004 and 2011, approximately 3 million tonnes of global annual copper demand shifted to substitutes, mainly aluminium.

Copper as a high performance electrical conductor and aluminium as a very light material are both essential for the energy transition and must therefore be treated equally. Aluminium production will continue to be eligible for indirect emission cost compensation in the future. **A possible omission of copper production would therefore lead to a competitive disadvantage for copper and competition distortion in the internal market**. This may lead to greater increases in substitution losses through aluminium.

b) Long Term Investment in EU ETS Area: Projections of demand in EU area, business demography

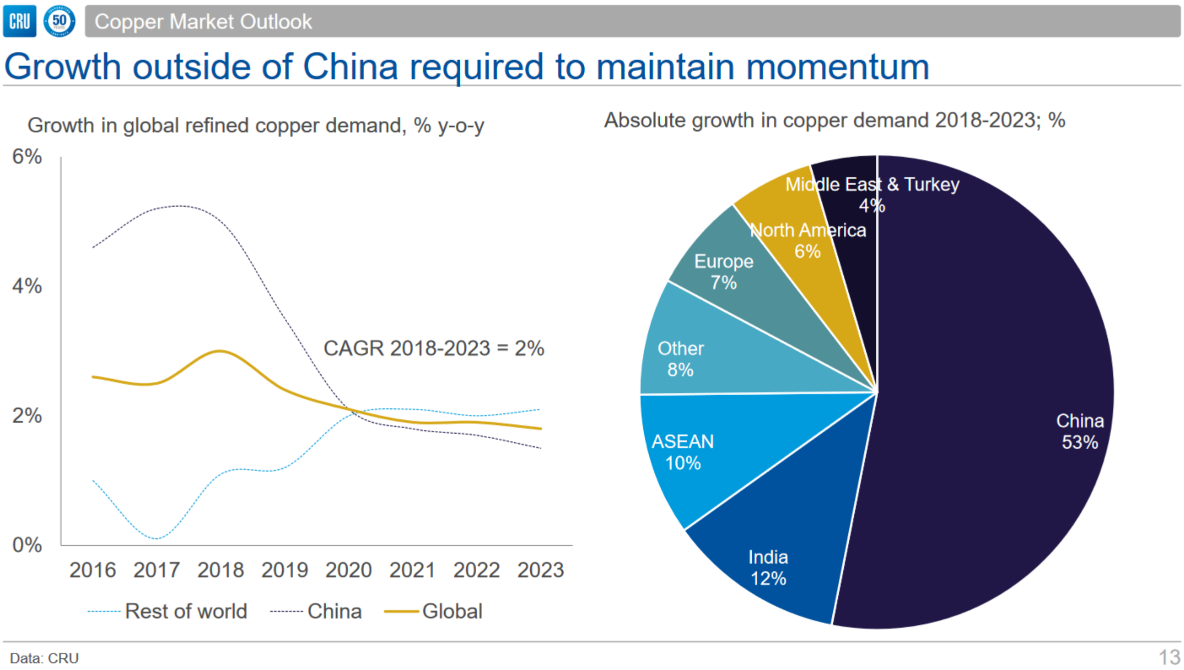
Projections of demand in the EU and outside

The demand for copper has doubled in the last 25 years and is projected to go up further. A recent report from McKinsey Global Institute predicts that copper consumption will rise by 43% by 2035 (https://copperalliance.eu/about-us/europes-copper-industry/).

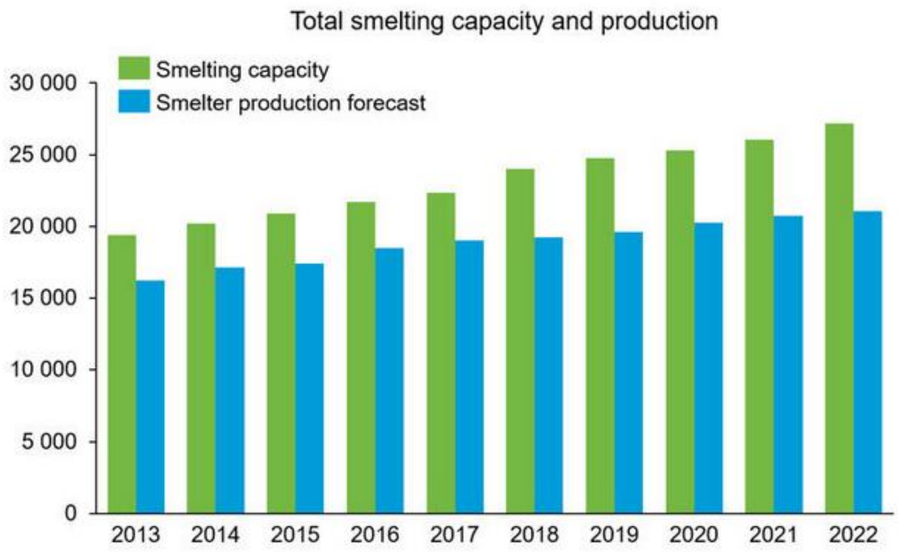
In the EU when looking at material flows, the growth has been stagnating since the onset of the financial crisis. Also relatively speaking, given higher material efficiency also the numbers for per-capita use of metals remains stagnant.

In a study provided by CRU and published in 2019 by the department of Energy and Mining of the Australian government (http://energymining.sa.gov.au/__data/assets/pdf_file/0004/344209/Erik_Heimlich.pdf), the mid-term outlook for the growth of the copper industry shows a highly mixed picture. While demand will substantially rise according to the World Bank http://documents.worldbank.org/curated/en/207371500386458722/pdf/117581-WP-P159838-PUBLIC-ClimateSmartMiningJuly.pdf and the average projected growth is around 2%, geographical repartition of this demand growth will be highly uneven.

Absolute demand growth until 2023 is concentrated in China with 53%, while growth in Europe with 7% is in the lower mid-ranging field.

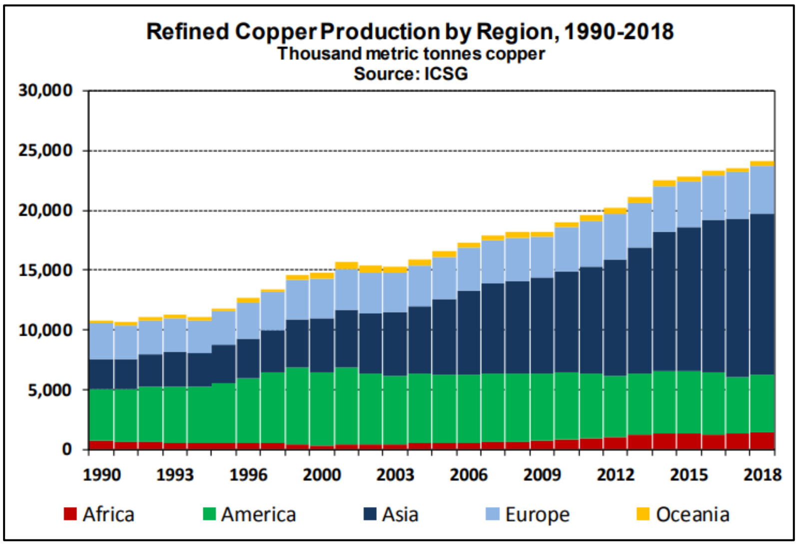


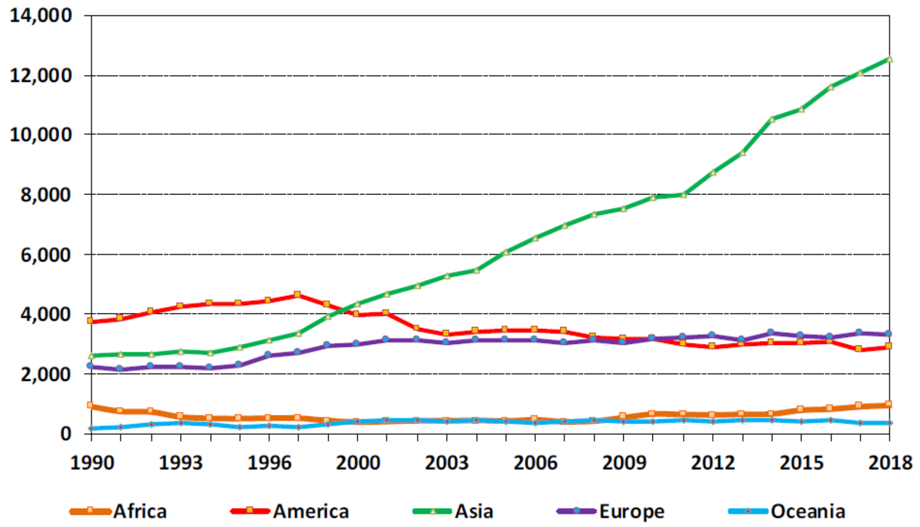
Increase in demand also leads to increase in capacities in refining and smelting –on a global level on average of 2.2%-3% - outstripping the demand increase of 2%:



Source: HSBC

European copper production did not show any significant growth, while Chinese copper production increased significantly. In the past several years, global copper output has increased by 50%, but European copper production has not shown any significant growth.



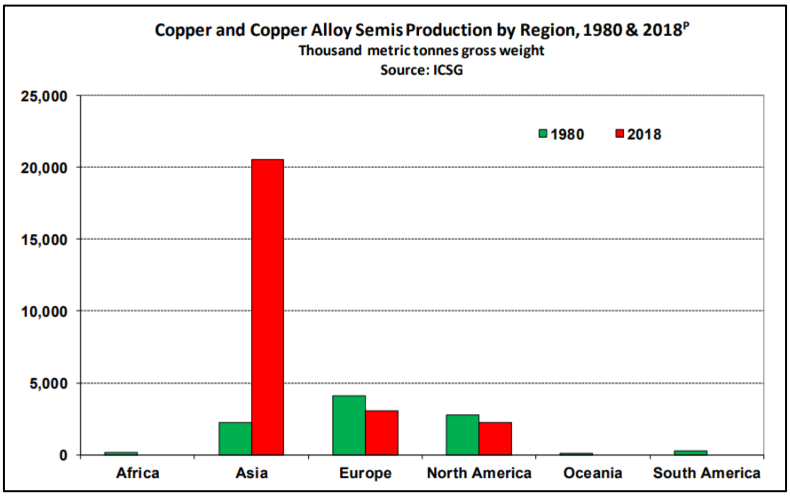


Asia's share of world copper smelter output jumped from 27% in 1990 to 62% in 2018 as smelter production in China expanded rapidly.

International Copper Study Group 18

Refined copper supply is growing significantly only in China and remains stagnating or falling in the rest of the world. In 2018 refined copper production outside China might have grown by less than 1%.

The Asian copper production increased more than 5 times and doubled its market share from 27% in 1990 to 62% in 2017 (source: International Copper Study Group). Copper production in Asia is the basis for a rising value chain (e.g. finished products). Asia accounts for 80% of semis output in 2018, compared to 23% in 1980.



These trends in demand patterns, combined with increased smelting capacity and output of semi-finished products in China are an indicator of investment leakage as growing demand did not lead to an increase of production capacities in Europe.

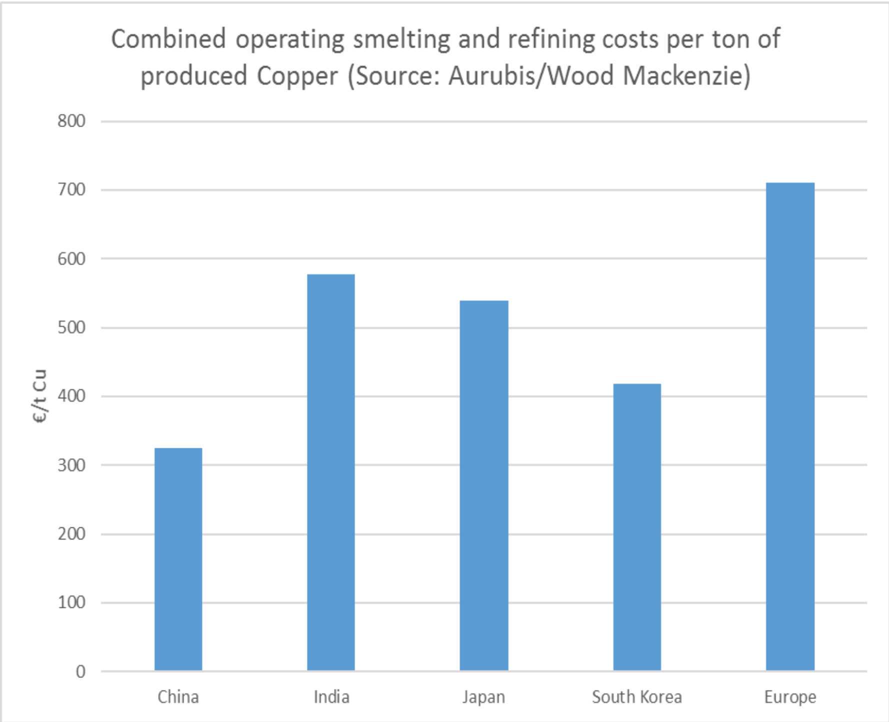
Projection of costs/ profit margins

Energy costs – mainly electricity- represent 25 to 30% of the overall operational costs for many of our smelting and refining installations. (https://www.eurometaux.eu/metals-blue-print-2050 page 17). Due to indirect carbon costs and as an energy-intensive industry in global competition, we are facing costs in the double-digit millions that our competitors do not have. Carbon leakage is emerging already by reducing asset values of the energy-intensive industry. This is already evident by rising production – and demand – numbers in Asia and not in Europe.

As TC/RCs operate independently of the metal price but are a function of negotiations between smelters and miners, this situation reduces the available cash for investments – for smelters all over the world. **However, in addition to this issue, smelters in the EU face higher energy and environmental costs than elsewhere, which increases the likelihood of carbon leakage. Annex 4.**

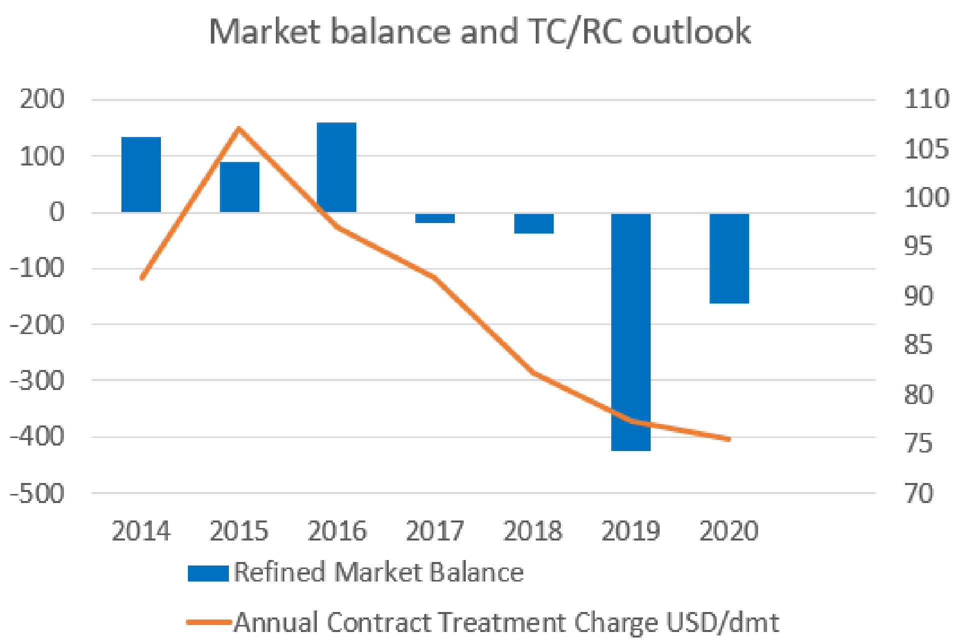
This can also be proven using concrete statistics (source: Wood Mackenzie data 2018). We can already see that the operating costs in the main competitor countries are lower than in Europe (% compared to Europe): China 46%, South Korea 59%, Japan 76%, India 81%.

From a purely economic perspective, production is therefore carried out where the costs are lowest, i.e. in Asia.



In addition, **the increase in demand and in capacity in China made it the defining player in the global copper market**. The higher the capacity and the lower the availability of concentrate, the lower the TC/RCs as it is mines who set the prices they are willing to pay to smelters. Increased capacity without matching demand – as in the case of China – reduces treatment and refining charges (TC/RC) and premiums, which are key revenues for smelters. Given the importance of the Chinese copper industry for TC/RCs due to the size of its industry, this constitutes a vicious cycle.

Demand growth being below capacity growth led TC/RCs to drop more than 19% in 2019 as compared to 2018. Given China's increase in capacity and the current tight output of concentrates, this trend will likely not reverse. The TC/RC benchmark in China was set for 2020 at 62$, which constitutes a 23% cut vis-à-vis the 80.80$ in 2019**.**



Source: S&P Global Market Intelligence, HSBC
https://www.outotec.com/products-and-services/newsletters/smelting-newsletter/smelting-issue-2-2019/copper-market-and-tc-rcs/

Worldwide the Copper Recycling Input Rate (or recycled content) was below 30% in recent years. **In the European Union, the rate has been stable around 45%,** meanwhile the rate keeps falling in China in recent years on more concentrate supply, remains stable in the US and is growing fast in Japan and in Italy. In countries like Turkey and Thailand the rate is converging to ~20%, while in Russia the copper recycling input rate has been affected in both directions in the past by a volatile fabrication output related to export tax volatility (source ICSG)

This also pertains to recycling and the ability to create a circular economy. The reduced recycling input in China is due to its policy to only allow pure and clean scraps into the country**. This also means that Europe is left with ever more complex scraps to secure its supply, which in its cost-structure more complicated as a business case than primary production**.
From scraps or waste with a certain metal content, one has to deduct:
- costs for separate collection or "mining" from dump sites
- costs for handling
- costs for pre-treatment to actually be able to retrieve the metal content
- costs for metal losses due to pre-treatment and treatment
- costs for treatment of the metal and disposal of the other materials
- costs for refining metal content to achieve a cathode-like quality

This often leaves a negative profit as no one is prepared to pay the incurred costs. Factoring in regulatory costs for CO_2 and environmental protection, the competitiveness of this business gets hollowed out as rising demand will increase the share of primary production (mainly outside Europe), and the incurred costs would be exacerbated due to compliance costs.

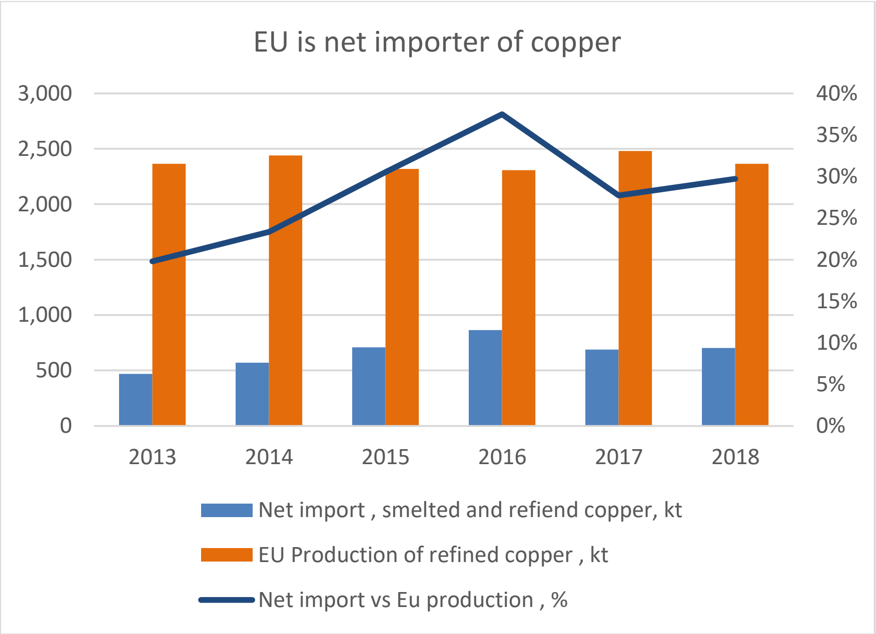
Given rising demand and China's national sword strategy, this situation will put EU smelters in a more dire position as high grade scrap markets will tighten and low-grade material will flood the markets, yet processing them might not be feasible.

c) Feasibility of investment re-allocation : Current trade patterns and net trade balance

While demand in Europe is growing, production in Europe is constant and net imports are increasing.

EU copper smelting and refining capacities can meet less than half of end-user demand. This structural shortage of EU-refined copper production is expected to continue, with the EU remaining a large net importer [Ref. NFM BREF chapter 1.2.3].

Although net imports of total copper (NACE 2444) versus own production are moderate, (0.46% to 3%), smelted & refined copper net imports are substantial, and increasing from 20% in 2013 to 30% in 2018. (Annex 2)



Cost factors and the uneven global playing field are fostering investment shifts towards activities in countries with better access to raw materials and/or lower energy costs.

Additional locally imposed costs such as indirect emissions costs, which are not faced by global competitors are a potential driver for long-term investment decisions and reallocation. Energy costs – mainly electricity- represent 25 to 30% of the overall operational costs for many of our smelting and refining installations. (https://www.eurometaux.eu/metals-blue-print-2050 page 17). Companies in the EU are also facing the strictest environmental regulations, e.g in terms of emissions to air and water and operate state-of-the-art techniques in accordance with the highest environmental standards. The costs for environmental protection, e.g. treatment of emissions and operation of reduction techniques, represent up to 25% of the total operating cost.

Hence these costs are one of the main decision factors for the continuation of investments at existing European locations. Higher electricity costs will act as a discouragement to invest in copper production in Europe.

The impact of the high EU environmental costs on the copper industry is exacerbated by an uneven global playing field and distorted markets. This is the case because of the introduction of very strict environmental and energy policies (including ETS); the fact that third countries such as China have industrial and trade policies to support metals industries, for example export restriction measures (raw materials), direct and indirect subsidies, dual pricing of energy, import measures and direct government provision of good and services; restrictions/obligations on suppliers of goods and services; obligations on industrial customers and consumers in the domestic market; restriction on domestic competition via market access limitations; etc.

There still remain incentives to retain production capacity and innovation activities in the EU. However, cost differences between EU-based companies and international competitors (especially related to energy, climate change and environmental topics) should stay in a reasonable range, or the benefits of being EU-based will be outweighed by these costs.

It is evident that the main investments in new capacities aimed at covering the projected increase in copper demand are being targeted outside of the EU, particularly in China (which, given its large coal-based electricity mix, carries a much higher carbon footprint compared to European production). Without the compensation that the EU non-ferrous industry received for indirect costs incurred in Phase III, carbon leakage in our sector would have been more profound.

The relocation decision outside the EU area would have both economic and environmental impacts. At the economic level, if EU companies relocate outside Europe then it impacts employment and creates adverse distributional effects as well as impairing economic growth within Member States. At the environmental level, if EU undertakings relocate in areas with less constrained climate policies e.g China then this would lead to higher global greenhouse gas emissions and will undermine the ETS objective of contributing to a global reduction of CO_2 emissions.

European copper producers are among the companies with the highest energy efficiencies globally.

European copper production has much lower footprint than global competitors. The carbon footprint of the global average copper cathode is 4 t CO_2 and the acidification potential (SO_2 emissions) is 60 kg SO_2 (*Based on cradle-to-gate life cycle assessment from the extraction of the copper ore at the mine to the production of copper cathode (2017) Reference , ICA – International Copper Association: Copper Environmental Profile, Sept. 2017)*

EU producers report twice lower CO_2 emissions (2.3 t CO_2/t) and only a third of the SO_2 emissions of global copper cathode Aurubis Environmental Statement 2019 www.aurubis.com.

The copper sector is very heterogeneous, and the production of refined copper (cathodes) are very electricity-intensive. Europe cannot afford to lose the energy intensive part of the copper value chain, by not compensating indirect emissions costs, because if one link of the value chain leaves, the others will follow. This may result in Europe becoming dependent on important key strategic metal.

III. Abatement potential

a) Adoption of best available technologies

Copper EU industry is the most energy efficient and sustainable in global production

Copper industry is one of the most energy efficient and sustainable in the global copper production. European smelters, refiners and fabricator companies continue to pioneer many of the world's leading metallurgical processing and environmental protection technologies. European copper producers are among the companies with the highest energy efficiencies globally.

Copper industry has implemented the best available techniques for energy efficiency in copper production, such as the use of a flash smelting furnace for autogenous smelting of copper concentrates, waste heat recovery and oxygen enrichment. The heat and process steam supply is covered by waste heat to a great extent. Process heat is used to produce electricity in the companies. All these measures contribute to reduction of carbon emissions.

The EU copper industry has largely implemented best available techniques for energy efficiency as required in the NFM BREF.

- In primary copper smelting, the flash smelting with oxygen enrichment as most efficient method of smelting copper concentrates is largely implemented. Use of a flash smelting furnace reduces the consumption of standard fuels due to the optimum utilisation of the heating value of the sulphidic concentrates and carbon present in copper concentrate. (Ref. NFM BREF chapter 3.3.8)
- Pyrometallurgical processes for copper production are highly heat-intensive and the process gases contain heat energy. Regenerative burners, recuperative burners, heat exchangers and boilers are applied to recover this heat. (Ref. NFM BREF chapter 2.2.) The hot gases produced during the smelting or roasting of sulphidic ores are almost always passed through waste heat boilers to recover energy and produce steam (Ref. NFM BREF chapter 2.2.).
- The excess heat that is produced during primary converting stages is used to melt secondary materials /copper scrap without the use of additional fuel (Ref. NFM BREF chapter 2.2.). This allows to save the energy, which otherwise will be needed to melt the copper scrap. For example by processing 150000 t copper scrap in the converters of primary smelter, around 101500 MJ per year are saved.
- The production of sulphuric acid from the sulphur dioxide emitted from smelting stages is an exothermic process. The heat generated in the gases during conversion, and the heat contained in the acid produced, is used to preheat the gas directed to the sulphuric acid plant or to generate steam and/or hot water. (Ref. NFM BREF chapter 3.3.8.1)
- The heat of off-gases is used to heat combustion air and gas through a heat exchangers. Hot process gases from the melting stages in shaft furnace are used to heat up the incoming furnace charge.

- Carbon containing off gases are used as a fuel to produce steam for district heating or for driving electricity turbines. (Ref. NFM BREF chapter 3.3.8.2)
- Companies in the sector implemented Energy Management systems and participate in energy efficiency programs (e.g. program initiated by Flemish government)

The CO_2 intensity of copper production reduced significantly from 2.67 t CO_2/t copper in 1990 to 1.62 t CO_2/t copper in 2015 or a reduction of 40%. These shifts can be explained by important efficiency gains in copper production (60% reduction in energy use per tonne of copper since 1990), in particular the shift to flash-smelting. Further efficiency gains came from new and modernised furnaces, renovated electrical equipment, efficient drying technologies, (residual) heat recovery systems and energy management systems (https://www.eurometaux.eu/metals-blue-print-2050/ page 45.) Note: Numbers are related to copper smelting and refining.

Industrial heat project (Aurubis, Hamburg). The use of surplus heat from production processes for district heating prevents more than 20,000 tons of carbon dioxide (CO_2) emissions per year. The company is working on the next phase to utilise the full heat potential, which will further save up to 140,000 t of CO_2 annually.

In 2011-2016, KGHM built its own gas and steam units operating in high-efficiency cogeneration. Two gas-steam units were installed in Polkowice and Głogów, each with a capacity of 42MWe (electric megawatts), 40 MWt (thermal megawatts).The electricity produced is 100% used for KGHM's own needs. 100% of the process heat is transferred to the district heating systems of Polkowice (23,000 inhabitants), Lubin (73,000 inhabitants) and Głogów (69,000 inhabitants). In 2016, KGHM replaced its shaft furnaces and converters by flash smelting furnace in Glogow Smelter.

Other large projects to enhance energy efficiency saw the implementation of steam turbines to produce electricity from process waste heat - by using waste heat, converting it into electricity and using residual heat. Atlantic Copper generates about 52 GWh/year of electricity and with new waste heat boilers starting by the end of 2020 self production of electricity will rise up to 77 GWh/year. Aurubis Luenen produces about 23 million KWh of electricity (about 14 % of the site's energy needs) and by this prevents 14,000 t of CO_2.

In Atlantic Copper high combustion efficiency burners are planned to be installed in the Flash Furnace to reduce the fossil fuel consumption.

Four wind turbines were built at the Olen site in Belgium in cooperation with a partner from the energy sector and two industry companies Aurubis and Umicore. Every unit has a capacity of 3.5 megawatt (14 megawatt in total). These wind turbines yearly provide 28 million kWh of electricity, which is directly used at the sites of the industry project partners and reduces the CO_2-emissions by 12,768 ton per year.

New plasma electric furnace for slag cleaning in Metallo Belgium.

Contribution to the energy transition by increasing energy flexibility. With the installation and flexible use of an electric steam boiler (10 MW) Aurubis Hamburg help maintaining grid stability. This plant alone could cut about 4,000 tons of CO_2 annually. [2]

[2] https://www.aurubis.com/en/public-relations/press-releases--news/news/2019/22.08.2019-full-steam-ahead-for-the-energy-transition-aurubis-inaugurates-new-power-to-steam-plant

Electrification of logistics equipment, including giant mining trucks is ongoing in Boliden.

Wieland has introduced high-temperature superconductor (HTS) technology for the induction heating of extrusion billets. The superconducting property of the magnetic coil works largely without a loss of energy, with efficiencies between 40 to 50% versus direct gas heating equipment, depending on the alloy. The technology received the German Environmental Award in 2009, and is an example for the electrification activities in the copper industry.

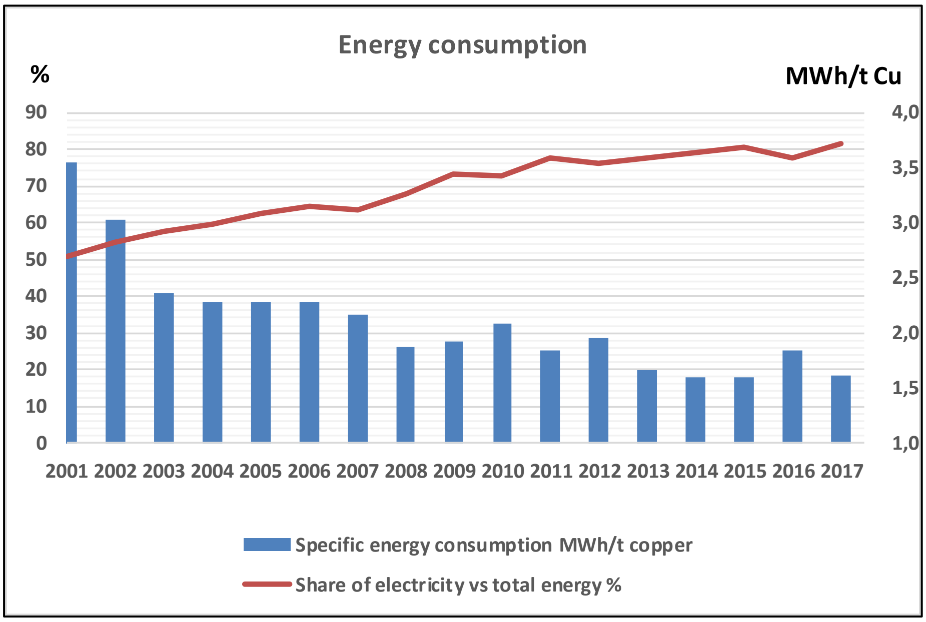
b) Current electricity consumption, Level of electricity intensity

Copper industry's operations are highly electro intensive

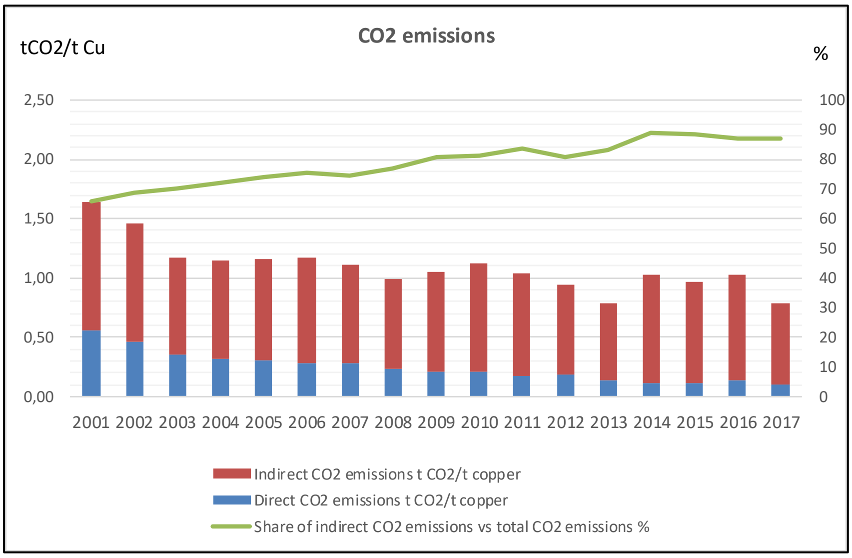
Electricity is used in important processes such as electrolytic copper refining, recovery of sulphuric acid from smelting and converting off gases, slag cleaning in electric furnace or concentrator, production of oxygen to replace air and increase the energy efficiency of the smelting process. In copper fabrication, electric induction furnaces are used for melting of copper alloy, for melting cathodes for oxygen free wire rod production, for rolling mills, drawing and extrusion processes. More support for electricity consumption will encourage even more use of electricity.

The share of indirect CO_2 emissions for the whole sector (NACE Code 24 44) is 60 % , while for the EU smelters, refiners and fabricators is 75% to 90%.

In recent years the copper industry has highly electrified its production, which contributed to energy efficiency and reduction of direct CO_2 emissions (see below examples from a primary smelter).



The copper sector is electro-intensive. Share of indirect CO_2 emissions in primary smelters may reach 85%.



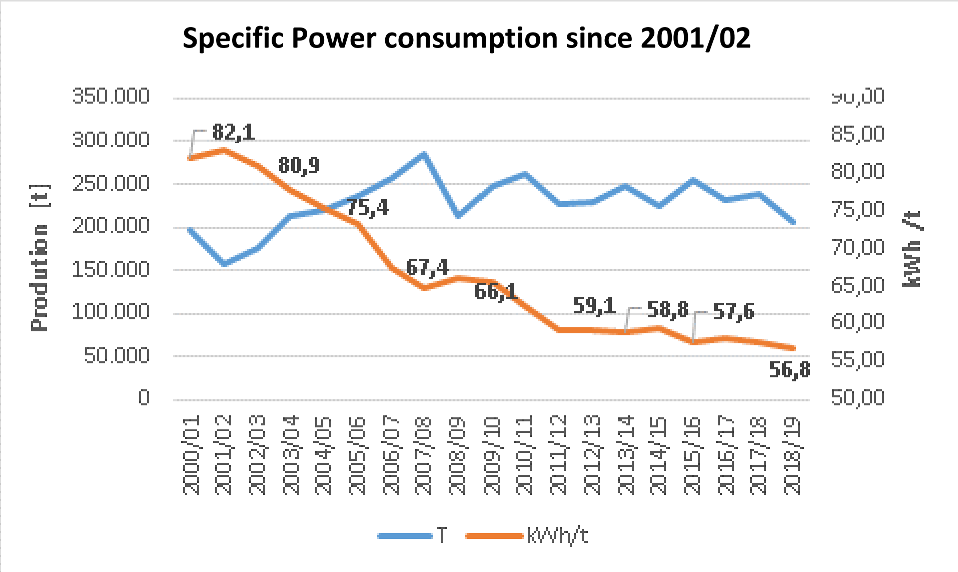
Direct electrification is due to higher environmental norms, requiring **implementation of cleaning systems for reduction of air and water emissions** such as bag filters, scrubbers, water treatment units. Up to 30% of electricity is consumed for environmental protection, such as off gas cleaning or waste water treatment. **This leads to increased electricity consumption.**

Further contribution to the environmental objectives such as improvement of air quality will increase the electricity demand. For example the copper smelter in Hamburg plans an investment of around € 100 million for additional roof suction and filter systems. The target is the reduction of diffuse emissions by more than 70%. This leads also to an additional yearly electricity consumption of 30 GWh hours, which is including 675.000 € yearly costs for indirect CO_2 emissions. As this project would not lead to additional output it will increase the operational costs by more than 1,5 € per ton of copper.

Indirect electrification occurs when more and more oxygen is substituting air during the smelting process. It results in improved energy efficiency, to decreased volume of exhaust gases and better control of air emissions. Oxygen production is very important and integral part of the copper production process. Use of oxygen enrichment of combustion air for copper smelting contributes to energy efficiency and decrease of direct carbon emissions. The production of oxygen requires significant electricity consumption, representing up to 24-40% of total electricity use in copper smelters[3]. Oxygen enrichment is considered as the best available technology to improve efficiency.
However, there is a regulatory discrimination between in-sourced and outsourced oxygen production, as the insourced oxygen production is eligible for compensation whereas the outsourced oxygen production is not eligible for compensation as per Current State Aid Guidelines.

Copper fabricators have improved their performance in energy efficiency during last years. Using a representative wire rod plant, it can be shown that large increases in electricity efficiency have already been achieved in the past, even though electricity price compensation was granted. So this such compensation does not prevent development of efficiency measures.

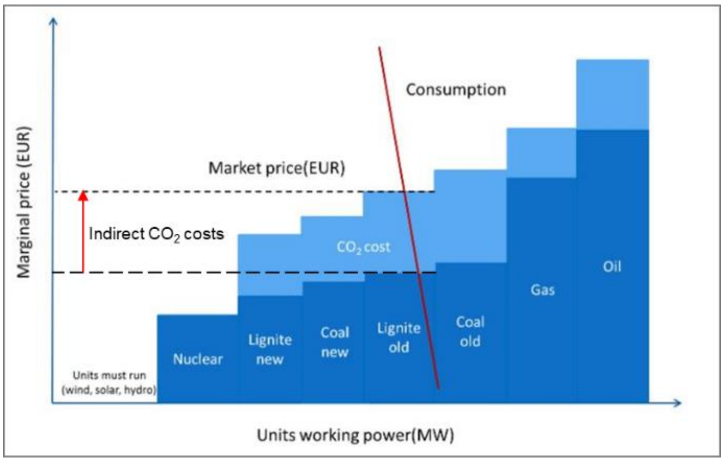
[3] Lauri Pesonen , 2017, "Understanding electrical energy use at copper smelters"



In fabrication of copper products electricity content varies between 20 to 90% of the energy content depending on the type of product.

Energy use per ton of product decreased in the past 20 years significantly but it is mostly constant over the last 5 years. Only with substantial investments in energy efficiency it has decreased in some fabrication sites by around 1% per year.

The copper sector as frontrunner for electrification will be disadvantaged by increasing electricity costs.

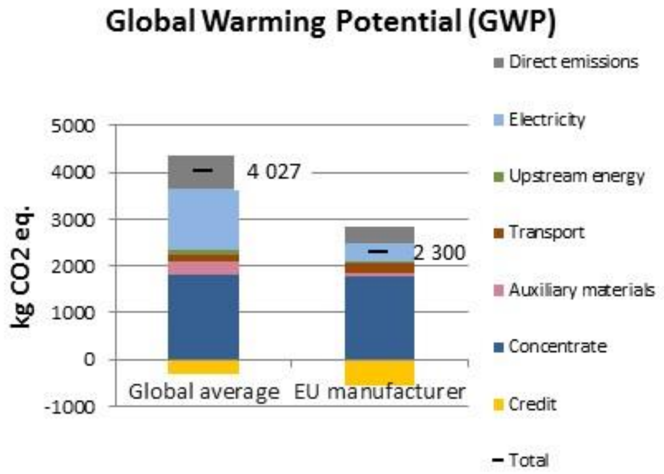


The electricity market price is set by the marginal power plant and contains its indirect CO_2 costs. Even CO_2 free electricity traded at market prices (e.g. renewable PPAs) have to bear indirect CO_2 costs

The European copper industry has already significantly contributed to the climate and environmental goals by implementing the best available technologies in energy efficiency and operating with highest environmental standards. Further potential to improve energy efficiency is very low. The reduction of direct CO_2 emissions is possible and the electricity price compensation will support the energy-efficient electrification of the sector.

The European copper production has much lower footprint than global competitors. The carbon footprint of the global average copper cathode is 4 t CO_2 and the acidification potential (SO_2 emissions) is 60 kg SO_2 (*Based on cradle-to-gate life cycle assessment from the extraction of the copper ore at the mine to the production of copper cathode (2017) Reference , ICA – International Copper Association: Copper Environmental Profile, Sept. 2017).*

EU producers report **twice lower CO_2 emissions and only a third of the SO_2 emissions of global copper cathode** (Aurubis Environmental Statement 2019; www.aurubis.com).

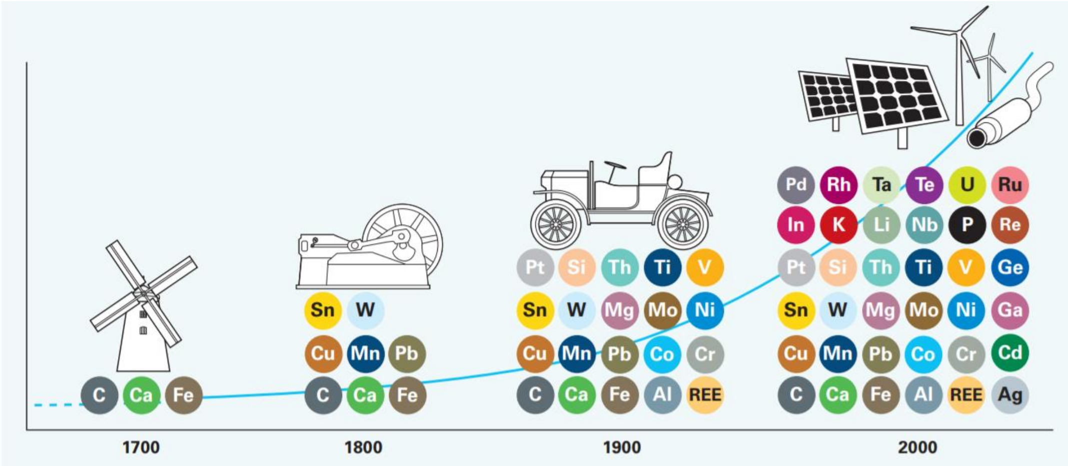


A key reason for this lies in the high input of recycling materials and the nearly complete conversion of raw materials into valuable products that leads to lower environmental impacts than the global competitors.

The copper industry contributes to resource efficiency and circular economy by processing important share of secondary raw materials. Recycled material constitutes an important component of the raw material supplies of the copper refining and manufacturing facilities. Copper can be recovered from the majority of its applications and returned to the production process without loss of quality in recycling. Having very limited access to domestic primary sources of copper, the EU industry has traditionally given much attention to so-called urban mines, relying, to a large extent, on scrap feed to reduce the large deficit of its copper raw materials trade balance. Almost 100 % of process copper scrap is recycled and, according to some studies, it has been estimated that 95 % of old copper scrap that becomes available is also recycled (NFM BREF).

Around 50% of copper produced in Europe are from secondary sources. European copper recyclers are world leaders in technology. The EU copper industry has developed advanced technologies and made considerable investments to be able to process a wide range of copper scrap, including complex, low-grade residues, and to comply at the same time with increasingly stringent environmental standards. Concurrently in Europe, copper and other metals are produced from increasingly complex recycling feeds. The average copper content in the raw materials is decreasing, while the proportion of minor metals such as zinc, tin, nickel, gold, and silver is rising distinctly, therefore the specific energy requirements for recycling are rising.
Moreover, the trend for miniaturization creates additional difficulties in recycling, especially for mechanical separation. The complexity of electronic scrap is changing with the new

technologies and this complexity will keep increasing. As a consequence energy/electricity intensity of production recycling processes is likely to go up.



The copper sector has already achieved highest environmental and energy efficiency standards at global level. Ambitious process improvements and emission reduction programs with a number of measures have been established during the last years. However, with this increase of productivity and efficiency, we are also reaching the technical limits. Companies already implemented many energy efficiency measures in the past, so it is challenging to optimise energy demand further because there are technological limits to reducing energy consumption and emissions. **With decreasing quality of raw materials, energy intensity of most efficient production processes is likely to go up**. Without the indirect compensation, further treatment of complex raw materials is unlikely to take place in Europe.

The above well indicates that in the copper sector, where the best available technologies to reduce electricity consumption have already been applied , there is little scope for further reduction in the specific electricity consumption, and consequently the indirect carbon costs. Therefore the risk of carbon leakage is very high.

IV. Fuel and electricity substitutability

a) Variability between undertakings in the sector

The copper sector is heterogeneous. The share of indirect emissions varies significantly depending on the scale of operation, complexity of raw materials, production routes, deployed technologies and process configuration, level of integration and stage in the value chain. There are small number of installations processing variety of raw materials (e.g. different grades of copper concentrates, blister, copper scrap and other complex materials with different content of copper and other metals), and each smelter has its own specificities (*NFM BREF*[4]).

The heterogeneity of the sector is well recognised in the recommendation to apply a fall-back approach and not a benchmark *(Ecofys and the Fraunhofer Institute*) *(https://ec.europa.eu/clima/sites/clima/files/ets/allowances/docs/bm_study-*

[4] Best Available Techniques (BAT) Reference Document for the Non-Ferrous Metals Industries

non_ferrous_metals_en.pdf).

According to the Organisation Environmental Footprint Sector Rules for Copper production ''Each European copper smelter has its own specificities that have impact on the environmental performance:
•production route
•product portfolio
•concentrate grade
•input of blister/anodes
•share and type of secondary materials, copper scrap, complex materials with different content of copper and other metals
•deployed technology
•scale of operations ….''

It concluded that "it is not meaningful to establish a benchmark in the copper production sector due to variability in the scale of operation and product portfolios, heterogeneous production routes and process configuration'' European Commission. Organisation Environmental Footprint Sector Rules –Copper production , https://ec.europa.eu/environment/eussd/smgp/documents/OEFSR_Copper.pdf

Smelters and refiners
Some EU smelters and refiners are clear primary smelters (Atlantic Copper, KGHM, Pirdop and Harjavalta) which use copper concentrates as their primary feedstock. Others are clear secondary smelters (Metallo Belgium/Spain, Montanwerke Brixlegg, and Aurubis Lünen), where the main feedstocks are scrap from the downstream value chain plus recycled products at the end of their life. Some have the flexibility to process both primary and secondary feedstocks, like Boliden Rönnskär and Aurubis AG Hamburg (NFM BREF chapter 1.2.3).

Sulphidic copper concentrates are the most important raw materials for the pyrometallurgical primary copper route. The primary smelters apply the flash smelting process. The smelting takes place autogenously in the reaction shaft without any external fuel addition, i.e. the chemical energy of the concentrate is utilised for smelting. Natural gas or fuel oil is used only to compensate the thermal losses and keep the molten bath hot. Copper concentrates with low iron and sulphur contents are smelted to blister directly in a "direct to blister furnace" (without the need for a converter stage (NFM BREF chapter 3.3.3). Ore grades are decreasing globally as the existing stock of mines ages. This is resulting in increased amounts of impurities in concentrates for each tonne of copper produced, leading to more energy to process those low grade copper concentrates.

A broad variety of secondary materials are used in secondary copper production and they are characterised by variable copper content and a broad concentration range of other metals or they are complexed with other elements (e.g. metallic, oxidic, sulphidic). Also, waste containing copper and other metals can be treated, e.g. electronic scrap. The input materials have to be appropriate for the process used though (NFM BREF chapter 3.3.4).

Various smelting processes are applied in secondary copper production depending on the input materials (NFM BREF chapter 3.3.4)
- ISASMELT furnace, for the smelting and converting to blister copper of a wide range of primary and secondary copper/lead-containing materials (dusts, mattes, dross,

slags, anode slimes, etc.), electronic scrap and some raw materials containing zinc and waste; furnace heated with fuel oil

- KRS, for the smelting and converting to blister copper of secondary copper materials such as copper alloy scrap, electronic scrap, copper-rich slags, copper dross, flue-dust, sludges; furnace heated with fuel oil.
- Electric furnace, for smelting a wide range of copper, and copper/lead-containing materials with an oxidic, sulphuric or metallic nature, i.e. dusts, dross, slags, low-grade precious metals containing anode slimes, copper alloy scrap, low-grade matte, copper/lead concentrates.
- Mini smelter and blast furnace, for smelting secondary oxidic and metallic copper-containing materials, using iron or copper/iron scrap as a reducing agent; Operated with natural gas/oxygen.
- TBRC, for the smelting of copper and copper alloy scrap, slag and complex concentrates; or for electronic scrap; heated with fuel oil or natural gas/oxygen.
- Contimelt, which is a continuous two-stage process, for melting and treating black and blister copper, high-grade copper scrap, and anode scrap to produce copper anodes. Natural gas is used for combustion and as a reducing agent.

For the fire refining stage of copper production, usually natural gas or fuel oil is used for combustion and, natural gas or propane as a reducing agent (NFM BREF , 3.3.5)

The electrorefining stage of copper production is based on electricity, the energy consumed is reported to be 300–400 kWh per tonne of copper, but the energy used is higher when higher impurity anodes are electrorefined. In some companies, a leaching and electrowinning process is installed, in order to treat copper granulate with a high amount of impurities and with a very variable copper content. (NFM BREF chapter 3.3.8)

Fabricators

With an output twice that of EU refinery output, the EU semis manufacturers directly use a significant amount of scrap in the range of one million tonnes per year. They must also turn to the international market to secure adequate supplies of refined copper. It is estimated that around 60 % of their raw materials come from primary sources, the remaining 40 % from the direct use of scrap and other secondary materials (NFM BREF chapter 1.2.3). The range of products supplied by the semis manufacturers is very wide, but consists primarily of rods, profiles, wires, sheets, strips and tubes. Applications are equally diverse, with semis used in sectors such as electrical engineering, automobiles, construction, plumbing, machinery, shipbuilding, aircraft, precision instruments, watches and clocks, etc.

The electrical wire rod sector accounts for around half of semis production. Whilst part of this is the integrated downstream output of copper refiners (e.g. KGHM and Aurubis AG), a significant part is upstream integrated by wire and cable producers (e.g. Nexans). Some companies in this sector have integrated foundries for the production of cakes, billets and other primary shapes for further processing. The others purchase these either from the smelters/refiners or from other semis manufacturers (NFM BREF chapter 1.2.3)

Wire rod is manufactured from high-purity copper cathodes, copper scrap or low alloyed copper through continuous processes, such as the Contirod process, the SCR (Southwire Continuous Rod) process or upwards casting processes. Copper and copper alloyed shapes (billets and cakes), strips and ingots are mostly produced in continuous casting, semi-continuous casting or in ingot casting processes. The melting of copper and copper alloys takes place in different types of furnace depending on the casting process and the raw materials. The furnaces are either fuel-heated (shaft furnaces or rotary furnace) or electrically heated (induction furnaces or heat resistivity furnaces). Shaft furnaces are used for melting copper cathodes and other pure copper scrap material for wire rod and for shapes or strip production. These furnaces are usually heated by natural gas burners. Electric furnaces are used to melt copper alloys and also pure copper (NFM BREF chapter 3.3.5).

Smelted & Refined copper production tonnage is about 30% of total copper as per NACE 2444. It represents the most energy intensive part of the sector with more than 80% of energy consumption (mostly electricity).

The high variability between undertakings in the copper sector in terms of production routes, deployed technologies, raw materials, and based on gas and electricity consumption in their production processes means, in absence of indirect emissions compensation, there is a high risk of substitution of electricity by fuel.

b) Unequal treatment of direct and indirect emissions

Electrification of industrial processes is a key element of decarbonisation. Increasing electricity prices and unpredictable indirect costs may harm the viability of electrification and reduce industry's ability to invest and execute decarbonisation efforts. Without compensation, the electricity costs will rise stronger than natural gas costs, for example, due to higher CO_2 factors. In the worst case, this may lead to a switch from electricity back to natural gas. As an example, green hydrogen produced by electricity in electrolysis would not be economically viable as a substitute for natural gas.

Example:
The total annual natural gas requirement of a copper smelter is 500 GWh. Replacement with hydrogen would require 600 GWh of electricity for hydrogen electrolysis (*Based on electricity consumption of electrolysis 4.2 kWh/Nm³ Hydrogen).* The direct emissions from natural gas that would be saved amount to approx. 100,000 t CO_2. However, the 600 GWh of electricity generate 456,000 t CO_2 (factor 0.76 t CO_2 / MWh).
The direct cost will be compensated with free allowances. At € 30 / t CO_2, the additional costs would amount to € 10.7 million p.a.

In a specific application, natural gas as a reducing agent in fire refining can be substituted very efficiently by hydrogen. This will save 6,300 t CO_2 direct emissions but will create 11,500 t CO_2 indirect emissions. Without indirect cost compensation such projects would be hampered.

The shaft furnaces for melting copper cathodes are one of main sources of current direct CO_2 emissions. There is a great potential here for the use of hydrogen for decarbonisation, which would entail additional considerable electricity requirements when it is generated in electrolysis. The industry has been already able to test an enrichment of up to 5% in one system without loss of quality. Enrichments up to 40% should be possible, according to the furnace manufacturers.

Example:
Shaft furnace in wire rod plant switching from natural gas to hydrogen (Enrichment 40%)
Natural gas 78 101 680 kWh

Hydrogen 10 413 557 Nm3
Electricity 43 736 941 MWh (*electrolysis 4.2 kWh/Nm³ Hydrogen)*
Additional indirect CO_2 emissions **33 240 tons**

In flat rolling production, in addition to cathode shaft furnaces for melting pure copper, induction furnaces for melting alloys are already being used at some locations. In a representative example, it can be calculated that with rising CO_2 prices and a deduction of the indirect CO_2 costs, it would be economically possible to replace the cathode shaft furnaces with induction furnaces.

	Costs per t CO_2		
Costs per t Cu	30,00 €/t	50,00 €/t	100,00 €/t
Shaftfurnace (Natural gas)	16,38	18,34	23,24
induction furnace (Eletricity)	23,54	28,10	39,50
induction furnace (Electricity) without indirect CO_2 cost	16,70	16,70	16,70

The examples above well indicate unequal treatment of direct and indirect cost compensation. Lack of adequate indirect cost compensation would block further investments in decarbonisation by electrification because it would undermine any planning security against rising electricity costs in the future.

As indicated above, the energy requirements to treat complex secondary materials will increase. The technologies for smelting and refining of secondary materials are mainly based on natural gas. Replacement of natural gas with electricity or hydrogen in some processes would be possible. However, the increase in electricity costs related to the EU ETS would not support this shift due to the current compensation for direct emissions costs linked to fuel consumption. Compensation for the indirect cost is essential to avoid a preferential treatment of fuel that could undermine energy efficiency measures.

About European Copper Institute:

Headquartered in Brussels and part of the International Copper Association, the European Copper Institute brings together the copper industry and its partners, to make a positive contribution to the UN Sustainable Development Goals and to support markets for copper. This by engaging both on regulatory matters and via market development programs, working in close cooperation with our members and non-members, who represent the whole copper value chain (copper producers, smelters, recyclers and fabricators).

Annexes

1. LME Letter
2. Copper sector data 2013 -2019 by Frontier Economics
3. Study on Smelters and refiners by Wood and Mackenzie , 2017-2019 data
4. Illustration of Revenue and Business Model by Wood Mackenzie.
5. ECI study: European Fabrication under NACE 2444 is challenged.

An HKEX Company

Guy Thiran
Director General
Eurometaux
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29/03/2019

Dear Guy Thiran,

THE ROLE OF THE LONDON METAL EXCHANGE

1. This letter sets out the role that the London Metal Exchange (LME) plays as the world centre for the trading of industrial metals.

General

2. The LME is a Recognised Investment Exchange (RIE) which is regulated directly by the Financial Conduct Authority (FCA). As a Recognised Investment Exchange, the LME has a statutory requirement to ensure that business on our markets is conducted in a fair and orderly manner, providing proper protection to investors. The LME was established in 1877 as an exchange for trading futures and options in base metals. In 2012 the LME was acquired by Hong Kong Exchanges & Clearing Limited (HKEX).

3. LME Clear is the clearing house for the LME. Launched in 2014 it was designed and built in consultation with the market to provide cost-efficient, EMIR compliant clearing services. It delivers innovative clearing and settlement services for traded transactions, providing a financial guarantee to every traded contract, acting as 'the seller to every buyer and the buyer to every seller'.

4. The LME brings together participants from the physical industry and the financial community to create a vital, robust and regulated market where there is always a buyer or seller, where there is always a price and where there is always the

opportunity to transfer or take on risk 24 hours a day. The Exchange provides producers and consumers of metal not only with a physical market of last resort but also the ability to hedge against the risk of rising and falling world metal prices.

5. The metals currently traded on the LME are aluminium, copper, lead, nickel, tin, zinc, two grades of aluminium alloy (the "Non-ferrous" products), steel scrap and steel rebar (the "Ferrous" products), and gold and silver (the "LMEprecious" products). The LME also recently launched seven new cash-settled futures; two hot-rolled coil contracts, two aluminium premium contracts, alumina, cobalt and molybdenum.

6. These metals are traded across our three trading venues; our open-outcry trading platform (the Ring), our highly liquid electronic platform (LMEselect) and our 24 hour inter-office telephone market. The LME is also home to the LBMA Platinum and Palladium Prices, which are discovered in a twice-daily auction. In 2018, 185 million lots were traded at the LME equating to $15.7 trillion and 4.1 billion tonnes notional with a market open interest (MOI) high of 2.3 million lots.

7. The LME is the global de facto price formation venue for the Non-ferrous metal products. The prices discovered on our platforms are used as the global reference and basis for physical trading as well as in the valuation of portfolios, in commodity indices and metal exchange-traded funds (ETFs). Our prices are trusted because the LME is the most liquid and most traded Non-ferrous metals market in the world and its global network of warehouses ensures the price is truly reflective of supply and demand.

8. All of the LME base metals contracts have close ties with the physical market. The prices discovered on the LME are used the world over in physical contracts, and because they can be physically settled using the LME warehouse network, LME prices converge with the physical market. The combination of price convergence, the global reach of the LME's storage facilities and listed metal brands, the fact that physical deals are negotiated using LME prices and our unparalleled levels of liquidity means the world gains a price it trusts. The physical market is supported by over 500 LME-approved warehouses in 35

locations across the USA, Europe and Asia. All of the LME warehouses are located in areas of net consumption and in free trade zones.

Price Discovery

9. The Ring, our open-outcry trading floor, is central to the process of price discovery. Each LME Non-ferrous metal is traded in highly liquid Ring sessions, which are representative of global supply and demand. Open-outcry trading is particularly important for the LME because of its unique prompt date structure.

10. The LME Aluminium contract was launched in 1978 and has since then become the LME's most liquid contract. Backed by the LME's strong ties with the physical industry, traders can benefit from tight spreads, a deep order book and a forward curve out to 10 years. The LME Official Price for aluminium, discovered on the Ring between 12:55 – 13:00, is used as the global reference price. Contracts for physical material across the aluminium value chain will typically use the LME price plus a regional premium and, depending where they fit in the supply chain, an additional premium value. The LME Aluminium Closing Price, discovered at 16:45, is used for margining and valuation purposes.

11. Copper was the first metal traded on the LME when it was founded in 1877. Due to its widespread use in industry, copper is viewed as being closely connected to macroeconomic events. Copper can be traded as far forward as 10 years, and has its LME Official Price discovered on the Ring between 12:30 and 12:35, and is used as the global reference. Contracts for material in a pre-refined state will be priced at a discount to the LME price, with material further along the value chain priced at a premium. The LME Copper Closing Price is discovered at 16:35.

12. Zinc first started trading on the LME in 1920, with the current specification introduced in 1986. It is one of the most liquid markets on the LME trading out to 5 years, and many analysts refer to its direct relationship with global economy because of its role in galvanising steel to protect it from weather and corrosion, making it essential for the construction industry. The LME Official Price for zinc has its price discovery on the Ring between 12:50 and 12:55, and is used as the

global reference. The LME Zinc Closing Price is discovered at 16:25.

13. The LME introduced the nickel contract in 1979, and is a key component in the making of stainless steel. 78% of the world's nickel is consumed by the stainless steel industry. The LME supports futures trading in the Nickel contract up to 5 years forward. The LME Official Price for nickel is discovered on the Ring between 13:00 and 13:05 and is used as the global reference price. The LME Nickel Closing Price is discovered at 17:00.

14. In 1928 the LME introduced the lead contract which currently trades as far forward as 5 years. The LME Official Price for lead is discovered on the Ring between 12:45 – 12:50 and is used as the global reference price. The LME Lead Closing Price is discovered at 16:35.

Yours sincerely,

R. Martin

Robin Martin
Head of Market Development

Copper Sector's updated data on Indirect Emissions, CO2 price, Indirect Emissions Costs, GVA, profit margin, turnover, LME price and actual output, Import Export and Investments

Data Provided by Frontier Economics

#	Data Item	Scope	unit	2013	2014	2015	2016	2017	2018	2019	Definition / Approach
1	Indirect emissions (based on SAG marginal emission intensity -*F1*)	NACE 2444	t CO2	4,053,757	4,275,990	4,332,385	4,647,891	4,937,637	n/a	n/a	convert SAG power sector CO2-factor into indirect emission intensity
	Average CO2 price based on year-ahead futures - *F2*		EUR/tCO2	4.51	5.96	7.65	5.34	5.81	15.52	24.89	Average price of future contract with same year delivery, EEX
	Indirect emissions costs (based on SAG marginal emission intensity)	NACE 2444	mn. EUR	18	25	33	25	29	n/a	n/a	Multiply (1/2) indirect emissions with forward price of year in question
2	Treatment Charge - Valid for smelting and refining only	USD/t		70	100	110	85	79	81	93	Bloomberg .CUTCRC G index
	Refining Charge - Valid for smelting and refining only	USD/t		154	220	243	187	174	179	204	Bloomberg .CUTCRC G index
3	GVA (EUR)	NACE 2444	mn. EUR	3,070	3,370	3,346	3,539	3,954	n/a	n/a	GVA at factor costs is the gross income from operating activities after adjusting for operating subsidies and indirect taxes. Value adjustments (such as depreciation) are not subtracted. Values as publised on Eurostat SBS: sbs_na_ind_r2 - Copper production [2008-2010: EU27_NACE 2] [2005-2007: EU27_NACE 1/1]; until 2012 EU27, afterwards EU28
4	LME price	Refining	USD/t	7,328	6,866	5,503	4,867	6,173	6,527	6,005	Bloomberg LMCADY Comdty; annual average (unweighted)
5	Actual output, Total	NACE 2444	kt Cu	7,776	7,825	7,679	7,729	8,149	8,139	n/a	Eurostat production quantity (all PRODCOMS), available from 2006 onwards
6	Actual output, Smelted & Refined Copper		kt Cu	2,366	2,439	2,319	2,307	2,480	2,363	n/a	Eurostat production quantity (PRODCOMS 24441200 + 24441330), available from 2006 onwards
7	Demand for Refined copper		kt Cu	4,032	4,304	4,314	4,397	4,506	n/a	n/a	ICSG
8	Net imports NACE 2444	NACE 2444	kt Cu	36	59	155	342	171	246	n/a	Import/Export Data Eurostat [DS-066341], NACE 2444
9	Ratio of NACE 2444 copper imports / actual output			0.46%	0.75%	2.02%	4.42%	2.10%	3.02%	n/a	
10	Net imports smelted & Refined Copper	Refined Cu	kt Cu	468	569	708	865	687	702	n/a	Import/Export Data Eurostat [DS-066341] (PRODCOMS 24441200 + 24441330)
11	Net imports smelted & Refined Copper Value	Refined Cu	mn EURO	2,723	2,984	3,763	3,772	3,785	4,035	n/a	
12	Ratio of smelted & refined copper imported tonnage / actual output tonnage		%	20%	23%	31%	37%	28%	30%	n/a	
13	Investment rate (Investment / Added Value), pls see worksheet investment data		%		17.8	16.6	15.1	14.2	n/a	n/a	Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E) [sbs_na_ind_r2]

Footnotes:

1 Current SAG Marginal intensity e.g. CWE - 0,76 t CO2/MWh, etc.

2 Corresponding to current SAG definition of CO2 price

3 Smelted & Refined contains following Prodcom Codes

24441200	Unrefined copper, copper anodes for electrolytic refining (including blister copper) (excluding electrocopper-plating, electroplating anodes)
24441330	Unwrought unalloyed refined copper (excluding rolled, extruded or forged sintered products)

Remarks: for the period 2013 to 2017,

1 Treatment charges and Refining charges (2) define processing revenue, GVA(3) and profit margins for the Smelting and Refining part, these are independent of LME Price(4).

2 GVA (3) has increased from 3 Bn to 3.9 Bn Euro, (+15%) and is not corelated to LME price.

3 Actual production output (5) has increased modestly from 7,776 to 8,139 ktCu,i.e. cumulative about 4.6% from 2013 to 2018, , i.e. no large capacity expansion has occurred.

4 Smelted & Refined copper production output (6) tonnage is about 30% of total copper as per NACE 2444. It represents the most energy intensive part of the sector.

5 Demand (7) for Refined copper has steadily increased by about 12% from 2013 to 2017

6 Although net imported tonnage of total copper (NACE 2444) (8) versus own production output (6) are moderate, (0.46% to 3%), the ratio of smelted & refined copper net imports (10) are substantial, and increasing (12) from 20% to 30%.

7 Net imported smelted and refined copper value (11) has increased in value from 2,723 mn Euro in 2013 to 4035 mn Euro in 2018=> clear evidence of carbon leakage

8 Investment rate (13)(Investment / Added value in %) has decreased steadily from 18% in 2014 to 14% in 2017 = > Clear evidence of investment leakage

Please see the Disclaimer

Submission by European Copper Institute to DG Competition, European Commission, based on Study by Wood Mackenzie, February 2020

Emissions Ratio Summary for 2017, 2018 and 2019 for Peer Group of Installations

		2017	2017	2018	2018	2019	2019	2017	2017	2018	2018	2019	2019
	CO2 Price €/t CO2	5,84	5,84	15,91	15,91	24,81	24,81	30	30	30	30	30	30
Operation	Ratio	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Smelter	Indirect emissions costs/GVA*	1%	4%	2%	14%	2%	20%	4%	21%	3%	26%	3%	25%
Refinery	Indirect emissions costs/GVA*	1%	1%	1%	1%	2%	6%	3%	6%	3%	7%	3%	7%
Smelter	Indirect emissions costs/Operating costs	1%	5%	2%	11%	3%	17%	4%	25%	3%	20%	4%	21%
Refinery	Indirect emissions costs/Operating costs	1%	4%	3%	8%	13%	5%	6%	18%	5%	15%	6%	16%
Smelter	Indirect emissions costs/Operating margin	1%	7%	minus	32%	3%	72%	4%	34%	minus	61%	3%	87%
Refinery	Indirect emissions costs/Operating margin	1%	2%	2%	6%	3%	9%	3%	9%	33%	11%	3%	11%
Smelter	Indirect emissions costs/Profit margin	1%	9%	minus	55%	minus	40%	6%	45%	minus	104%	minus	48%
Refinery	Indirect emissions costs/Profit margin	1%	2%	2%	8%	3%	11%	4%	12%	4%	15%	4%	14%

Source: Wood Mackenzie

Smelters	Refiners
Pirdop	Aurubis - Hamburg
Aurubis - Hamburg	Glogow I
Harjavalta	Glogow II
Huelva	Huelva
Ronnskar	Legnica
Glogow I	Pirdop
Glogow II	Pori
Legnica	Ronnskar

NOTES:

(*) GVA is defined as EBITDA + employee costs;
this analysis uses Operating Margin + Labour Costs as defined by Wood Mackenzie to approximate GVA

Cost Definitions

Gross Value Add (GVA) = Operating Margin + Labour
Operating Margin = Total Revenue – Net Cash Costs (NCC)
Profit Margin = Total Revenue – Total Smelting Costs
Total Smelting Costs = Net Cash Cost + Depreciation
Total Revenue = Treatment Charges (TCs) + Bonus Cu + Bonus Ag + Bonus Au + Other Downstream Revenue
Net Cash Costs (NCC) = Operating Costs + Credits (Energy and Sulphur)
Operating Costs = Labour + Electricity + Fuels + Maintenance + Consumables + Other on-site costs

Assumptions

For the purpose of these calculations, total copper production is used.
Total copper production includes copper from primary (concentrate) and secondary sources (scrap).
Auxiliary plants to the smelter/refinery, such as the sulphuric acid plant and the oxygen plant, are included in the energy calculations.

Table 1: Historical Average Annual EUA Prices (€/tCO2, nominal) Source: Wood Mackenzie

Average EUA		2017	2018	2019
€/tCO2		5.84	15.91	24.81

Source: Wood Mackenzie, European Union Trading Scheme

Table 2: Maximum Regional CO2 Emission Factors in Different Geographic Areas (tCO2/MWh)

Country	Emission Factor (tCO2/MWh)
Germany	0,76
Poland	0,88
Spain	0,57
Bulgaria	1,12
Finland	0,67
Sweden	0,67

Source: Wood Mackenzie, European Union Trading Scheme
(https://www.emissionseuets.com/attachments/185_MAXIMUM%20REGIONAL%20CO2%20EMISSION%20FACTORS.pdf)

Table 3: Historical Dollar Euro Exchange Rate , Source: Wood Mackenzie

Year	Exchange Rate (USD:EUR)
2017	1.13
2018	1.18
2019	1.12

Source: Wood Mackenzie, European Union Trading Scheme

Disclaimer

Smelter and Refinery Complex Business Model

Prepared for ECI

9 March 2020

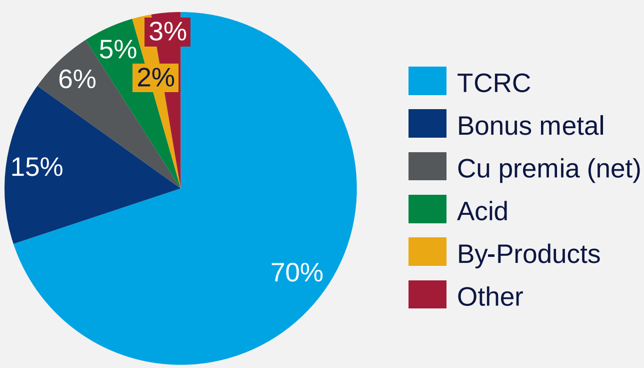
TCRCs originally reflected the individual smelting and refining costs, but now are based on demand and supply of copper concentrates

Combined Smelter Refinery Margin

= Metal Sales + TCRC Income − Cost of Sales − Operating Costs

Smelter-Refinery Complex Revenues (Indicative)

- For non-integrated smelters, **metal sales** represent the bulk of revenues
- For integrated players, the **TCRCs** often account for approximately 70% of integrated cathode production revenue



Additional descriptions

- **Bonus metals** relate to copper, silver and gold that are recovered in addition to the contractual amounts paid to the seller
- **Copper premia** (additional regional charge)
- **Credits** (revenues from power generation, acid revenues, by-products such as include nickel sulphate, selenium, platinum group metals)
- **Other downstream revenues** from items such as slag sales and other contained metals

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TCRCs originally reflected the individual smelting and refining costs, but now are based on demand and supply of copper concentrates

Combined Smelter Refinery Margin

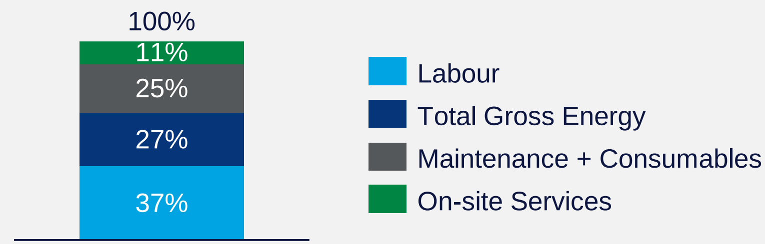
= Metal Sales + TCRC Income − Cost of Sales − Operating Costs

Smelter-Refinery Complex Cost of Sales

- **Cost of Sales** represents the vast majority of smelter-refinery costs, and typically includes:
  - Cost of concentrate (can be up to ~96% of cost), taking into account payable copper, gold and silver
  - Cathode marketing costs
  - Any scrap purchase costs
  - TCRC's for the extraction of payable elements from slimes produced during the smelting process

Smelter-Refinery Operating Costs (indicative EU)

- **Operating costs** for most smelter-refineries are dominated by labour and energy costs



Smelter-Refinery Complex Margins

- **TCRC revenues** are driven by supply/demand for concentrates (not LME), with China continually adding capacity
- **Costs** are driven mainly by LME prices and energy and labour costs
- Revenues and costs are not correlated, exposing the sector to a high degree of volatility, and margins tend to be low

Volatile and generally-depressed smelter-refinery margins reduce the attractiveness of investing in the European copper sector

Without continued indirect compensation, the competitiveness of EU copper smelters and refiners may be challenged significantly

Controllable and uncontrollable cost drivers

Several factors influence smelter/refinery operating costs. Some are internal and inherent to the asset, and thus can be manipulated to an extent to improve performance and reduce costs. Others are external, depending on factors such as global or regional markets or government policy and cannot be changed from an operational point of view

Internal factors that affect operational costs are:

- Production: concentrate treated, anode production, sulphur by-products production
- Electricity, fossil fuels and consumables consumption
- Manpower
- Maintenance programmes
- Other on-site costs

External factors that affect operational costs are:

- Utility prices: electricity, fuels, water
- Labour
- Concentrate grade and complexity
- Environmental regulations
- Relationship with the local community

NOTE: Because EU refining is largely dependent on EU smelting, if the EU smelting sector ceased to be viable, then the EU refining sector would likely also be put at risk

EXAMPLES OF VOLATILITY

- **2018-2019 Indirect Emissions Cost / Profit Margin:**
  - The maximum value for this emission ratio in 2018 was 104%, which dropped to 48% in 2019
  - Some of assets experienced a significant increase in concentrate quality (better grades, etc.), which resulted in improved profits in 2019 than in 2018
  - Emissions cost at a 30€/t carbon price assumption remained broadly similar in 2019, however the increased profit halved the emission ratio
  - While some costs are mostly controllable by an operator, concentrate quality can vary widely within contractual limits from year to year and from asset to asset
- **Negative emissions ratios:**
  - While emissions costs are always positive, at times smelter-refineries experience negative operating and/or profit margins
  - These years with losses appear as “minus” in the emission ratios in our summary
  - This approach was selected to avoid confusion, because negative ratios (emissions costs at an unprofitable company) are effectively even more problematic than a large positive ratio (emissions costs that would eliminate most or all of profits at a company barely managing to break even)

Disclaimer

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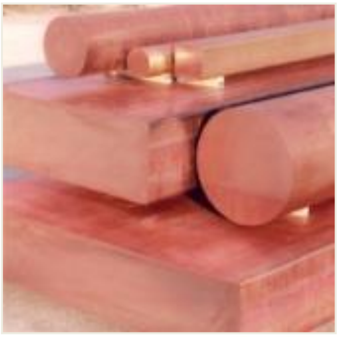
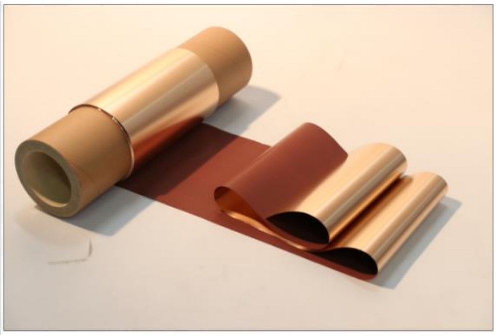
Annex 5 to Copper (NACE 2444) sector's Application

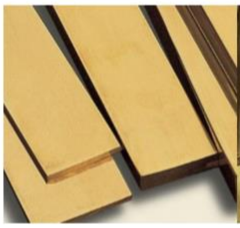
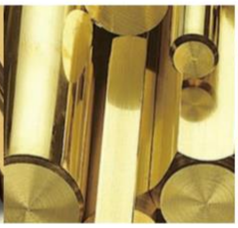
European Fabrication under NACE 2444 is challenged if Copper sector would not be eligible for Indirect Emissions compensation:

Based on the request during the meeting of Copper sector delegation to DG Competition on 19/February/2020, ECI has collected electricity and profit margin data on representative products of the following Prodcom Codes: from the fabricator in different member states:

- in the Nordic region,
- CWE region,
- Iberian region and
- Greece.

Prodcom	Description
24442200	*Copper and copper alloy bars, rods, profiles and hollow profiles (excluding bars and rods obtained by casting or sintering, copper wire rod in coils)*
24442330	*Copper wire, refined (transv. section > 6 mm), of copper alloy*
24442350	*Copper wire with cross-sectional dimension > 0.5 mm, <= 6 mm (excluding twine or cord reinforced with wire, stranded wire and cables)*
24442370	*Copper wire with cross-sectional dimension <= 0.5 mm (excluding twine or cord reinforced with wire, stranded wire and cables)*
24442400	*Copper and copper alloy plates, sheets and strip of a thickness > 0.15 mm (excluding expanded copper metal, insulated electric strip)*
24442500	*Copper foil, of a thickness (excluding any backing) <= 0.15 mm*
24442630	*Copper tubes and pipes*
24442650	*Copper and copper alloy tube/pipe fittings including couplings, elbows, sleeves, tees and joints excluding bolts and nuts used for assembling/fixing pipes/tubes, fittings with taps, cocks, valves*



Conclusions:

The Fabrication part of NACE 2444 is at significant risk of carbon leakage and investment leakage, just like the smelting and refining part, with the following specificity:

1. In fabrication of these products electricity content varies between 20 to 90% of the energy content depending on the type of product.
2. Energy use per ton of product decreased in the past 20 years significantly but it is mostly constant over the last 5 years. Only with substantial investments in energy efficiency it has decreased in some sites by around 1% per year.
3. Profit margins of some of the fabricated products have even negative values because of fierce competition and decreasing processing revenues by scrap owners and due to imports to EU from third countries with no CO_2 taxes etc.
4. In fact, at 30 € per ton CO_2, indirect emissions costs are from up to 20 % of the profit margin for copper foil, some brass products and exceed profit margins completely for other brass products. For copper tubes and copper extruded products it is in the range of 5 -15%. Indirect CO_2 costs for wire rod production represent around 16 % of the profit margin. For semi production (sheets and strips) the indirect cost can be 75 % and more , even negative for specific locations.
5. Essentially, scrap owners are from time to time inclined to get the scrap processed out of Europe, with less stringent environmental norms and no indirect emissions costs.
6. Furthermore increased import of finished parts made of copper from outside EU put additional pressure on the EU copper fabricators.
7. Without indirect emissions compensation, and given the stricter environmental regulation, the fabrication of these products in Europe is not at all attractive for new investments. Hence, the industry is suffering further and the capacity of the European copper industry is going down.
8. The closure of some of the fabricators such as, MKM (Brass) in UK, BCZ (Tubes) in Belgium, LDM (Brass) in The Netherlands is a proof that carbon leakage is already present.
9. Exact data for these parameters is available with ECI on strictly confidential basis if required by the European Commission.

About European Copper Institute:

Headquartered in Brussels and part of the International Copper Association, the European Copper Institute brings together the copper industry and its partners, to make a positive contribution to the UN Sustainable Development Goals and to support markets for copper. This by engaging both on regulatory matters and via market development programs, working in close cooperation with our members and non-members, who represent the whole copper value chain (copper producers, smelters, recyclers and fabricators).